DEPARTMENT OF DEFENSE

# MODELING AND SIMULATION (M&S) MASTER PLAN

October 1995

Under Secretary of Defense
for Acquisition and Technology

October 17, 1995

FOREWORD

The DoD Modeling and Simulation Master Plan is authorized by DoD Directive 5000.59, "DoD Modeling and Simulation (M&S) Management," January 4, 1994. The DoD M&S policies, organizational responsibilities, and management procedures are outlined in DoD Directive 5000.59. This Plan is the Department of Defense's first step in directing, organizing, and concentrating its M&S capabilities and efforts on resolving commonly shared problems. The immense breadth and scope of DoD M&S uses, combined with the relative immaturity of many segments of the larger DoD M&S community and its technology, ensure this first iteration is incomplete. Over time, with the active participation and support of the DoD M&S community, this Plan will mature to address the full range of issues confronting DoD M&S. Many policy and technical issues may not be identified or resolved; however, this plan, with the management framework and policies established in DoD Directive 5000.59, provides a means to achieve common technical and policy consensus. This plan is intended to be dynamic and flexible, a living document that will evolve as technology matures and consensus develops on policy and programmatic issues.

This Plan:

(1) Applies to the Office of the Secretary of Defense (OSD) Principal Staff Assistants (PSAs), the Military Departments, the Chairman of the Joint Chiefs of Staff, the Unified Combatant Commands, the Inspector General of the Department of Defense, the Defense Agencies, and the DoD Field Activities (hereafter referred to collectively as "the DoD Components" per DoD Directive 5000.59).

(2) Focuses on management and an M&S technical support and strategy to facilitate interoperability and reuse, where appropriate. Future iterations of this Plan will include additional management and functional area objectives to more specifically address the requirements, plans, and investments of each functional area.

(3) Provides flexibility for the DoD Components to exercise their own authority and judgment in executing their management responsibilities.

(4) Applies to all of the DoD Models and Simulations used after the effective date of this plan and it is effective immediately

The DoD Components may issue supplementary instructions when necessary to provide for unique requirements within their organization. The DoD Components shall forward recommended changes to the Plan through their DoD Component M&S focal point to:

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Copies of this document can be obtained from the Defense Modeling and Simulation Office's home page on the Internet at:

http://www.dmso.mil

The DoD Components may obtain copies of this Plan through their own publication channels, approved for public release; distribution unlimited. Authorized registered users may obtain copies of this Plan from:

Defense Technical Information Center
8725 John J. Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218.

Other Federal Agencies and the public may obtain copies from:

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# CHAPTER 1

# GENERAL INFORMATION

## A. PURPOSE

This Plan:

1. Implements policy in DoD Directive 5000.59 (reference (a)), subsection D.2.

2. Establishes the DoD vision for DoD Modeling and Simulation (M&S) and a process for defining future M&S-based capabilities.

3. Outlines a strategy for achieving future DoD M&S-based capabilities.

4. Establishes a DoD M&S baseline to document current M&S capabilities and developments and as a reference to measure future progress.

5. Assigns implementation responsibilities.

6. Provides guidelines for development, cooperation, and coordination of DoD M&S efforts.

7. Is the initial step in an iterative process that provides for development of functional objectives, technology development road maps, and strategies for achieving current and future DoD M&S objectives.

8. Will provide, through successive iteration and refinement, a basis for the development of supporting plans and programs, including the DoD MSIP.

9. Establishes DoD M&S objectives, identifies actions, and, where possible, assigns responsibilities for accomplishing them.

10. Provides a basis for developing supporting plans and programs, including the DoD MSIP, and the DoD Component's M&S master and investment plans.

11. Provides justification for resource allocations to M&S within DoD Component programming and budgeting processes. Note: Chapter 4 milestones for actions are planning factors for execution of the various tasks. They may require adjustments based on delays in technology advancements and/or limitations in the Planning, Programming and Budgeting System (PPBS) process.

12. Fosters the integration of the defense and civilian M&S bases into a unified national and international base using common standards, processes and methods.

B. RESPONSIBILITIES

1. The Under Secretary of Defense for Acquisition and Technology shall:

a. Through iterative development and implementation of the Department of Defense Modeling and Simulation Master Plan (MSMP) and MSIP, strengthen the uses of M&S across the missions and functions of the Department of Defense.

b. Develop supporting plans, programs, policies, and procedures for DoD M&S to support the DoD MSMP and MSIP, in coordination with the DoD Components, as required.

c. Review the DoD MSMP as needed to support the PPBS cycle and coordinate changes with the DoD Components.

d. Develop and implement a DoD MSIP, update it as required and coordinate that plan with the DoD Components.

e. Establish a DoD M&S Resource Repository (MSRR) system.

f. Establish a DoD M&S Information Analysis Center to support and enhance the coordination of DoD M&S developments.

g. Through the DoD Executive Council for Modeling and Simulation (EXCIMS):

(1) Recommend new and/or revised DoD M&S objectives and the strategies, plans, programs, and investments to achieve them for incorporation into revisions of the DoD MSMP and/or MSIP.

(2) Evaluate and recommend that the DoD Components be designated as a DoD M&S Executive Agents (MSEAs), as required.

(3) Foster programs to develop and, where applicable, implement DoD M&S interoperability standards and protocols that support the DoD MSMP and MSIP.

h. Oversee implementation of the DoD MSMP and MSIP, and ensure these plans are resourced to meet objectives.

i. Designate Principal Staff Assistants (PSAs) or Heads of the DoD Components, as appropriate, as "Primary Responsibility" (PR) for all actions not yet assigned in this plan.

j. Take action on all Chapter 4 actions where the Under Secretary of Defense for Acquisition & Technology (USD(A&T)) (or its subordinate organizations) is identified as the agent for PR.

k. Through the Director, Defense Research and Engineering:

(1) As Chair of the EXCIMS, monitor implementation and execution of the DoD MSMP and MSIP and provide the USD(A&T) periodic progress reports.

(2) Provide EXCIMS-developed recommendations regarding new DoD M&S objectives and changes to the DoD MSMP and/or MSIP to the USD(A&T).

(3) Through the Director, Defense Modeling and Simulation Office (DMSO):

(a) Be the full-time DoD focal point for the maintenance of the MSMP and MSIP as outlined in Appendix Y, Plan Maintenance.

(b) Establish Modeling and Simulation Working Group (MSWG) Sub Working Groups, and Task Forces as needed to support the development and implementation of the DoD MSMP and MSIP.

(c) Staff and distribute changes and revisions to DoD M&S plans, programs, policies, procedures, and DoD Publications that support the DoD MSMP and MSIP.

2. The Assistant Secretary of Defense for Command, Control, Communications, and Intelligence shall:

a. Ensure that current and planned Command, Control, Communications, and Intelligence (C3I) systems and M&S, as appropriate, are compatible.

b. Through the Director, Defense Information Systems Agency (DISA), ensure that:

(1) Current and planned new developments or modifications to the existing DoD communications infrastructure and DoD M&S are compatible.

(2) New or modified DoD communications and DoD M&S standards and M&S protocols are compatible.

c. Through the Director of the Defense Intelligence Agency, coordinate intelligence-related support for this plan with the U.S. intelligence community.

d. Through the Director, Defense Mapping Agency (DMA), as the DoD MSEA for Terrain, take actions where assigned as "PR" in Chapter 4.

e. Take actions as needed to implement responsibilities assigned to a PSA, as outlined in subsection B.3., below.

3. The Office of the Secretary of Defense Principal Staff Assistants shall:

a. Assist, as appropriate and able within their resource constraints, in the development, revision, and budget execution of the DoD MSMP and MSIP.

b. Plan and provide resources to carry out their functional M&S responsibilities in support of the DoD MSMP and MSIP according to PSA priorities.

c. In coordination with the DoD Components, develop M&S functional objectives and supporting investment programs, as required.

d. In coordination with the DoD Components, develop M&S functional area appendices to the DoD MSMP and MSIP, as required.

e. Review, coordinate, and approve DoD M&S plans, programs, policies, procedures, and DoD Publications that support the DoD MSMP and MSIP.

f. When designed as a DoD MSEA, assume DoD-wide responsibility for managing DoD common- or general-use M&S applications, including the development of relevant standards, protocols, and data bases, in response to guidance from the USD(A&T).

g. Establish elements of the DoD MSRR system, as appropriate.

h. Assume, as appropriate, DoD Component responsibilities as stated in subsection B.4., below.

i. Take action, as appropriate, on all Chapter 4 actions where identified as PR.

4. The Heads of the DoD Components shall:

a. Assist, as appropriate and able within their resource constraints, in the development, revision, and budget execution of the DoD MSMP and MSIP.

b. In coordination with the other DoD Components, develop M&S functional area appendices to the DoD MSMP as required. Plan, program, and provide resources to carry out their M&S responsibilities in support of the DoD MSMP and MSIP.

c. Review, coordinate, and approve DoD M&S plans, programs, policies, procedures, and DoD Publications that support the DoD MSMP and MSIP.

d. Publish a MSMP and MSIP that supports objectives in the DoD MSMP and MSIP.

e. Establish elements of the DoD MSRR system, as appropriate.

f. Foster joint and/or cooperative M&S development with the other DoD Components in support of the DoD MSMP and MSIP objectives.

g. Ensure that their M&S master and investment plans support this plan.

h. Annually, or upon change or revision, provide the USD(A&T) copies of their current M&S Master Plan and Investment Plan.

i. Identify their M&S requirements, projected over the next 6 years, to the USD(A&T) within 6 months of the publication of this document, and provide updates as changes occur.

j. Take action(s), as appropriate, for all Chapter 4 actions where the DoD Components and/or any of their subordinate organizations is identified as the agent for PR.

5. The Chairman of the Joint Chiefs of Staff shall:

a. Coordinate and manage the execution of this plan with the Unified Combatant Commands (UCCs).

b. In coordination with the UCCs, develop a consolidated and prioritized listing of joint validated operational requirements that might be fulfilled through M&S and provide it to the USD(A&T).

c. In coordination with the UCCs and through the EXCIMS, propose new DoD M&S objectives and investments to the USD(A&T) for incorporation in the DoD MSMP and MSIP.

d. In coordination with the UCCs, document M&S benefits and report them to the USD(A&T).

e. Execute DoD Component responsibilities stated in subsection B.4., above.

6. The Commanders-in-Chief of the Unified Combatant Commands, shall:

a. Coordinate and execute assigned responsibilities of this plan through the Chairman of the Joint Chiefs of Staff.

b. Identify and validate operational requirements that might be fulfilled through M&S to the Chairman of the Joint Chiefs of Staff for consolidation and prioritization.

c. Through the Chairman of the Joint Chiefs of Staff, propose new DoD M&S objectives and investments for forwarding to the USD(A&T) and possible incorporation into the DoD MSMP and MSIP.

d. Provide inputs to the Chairman of the Joint Chiefs of Staff on benefits of M&S in their commands.

e. Prepare supporting plans to implement the DoD MSMP and MSIP within their commands.

7. The Director, Operational Test and Evaluation, shall:

a. In coordination with the USD(A&T) and other DoD Components, develop M&S policy for application to operational test and evaluation.

b. Assume DoD Component responsibilities stated in subsection B.4., above.

# CHAPTER 2

# DOD VISION FOR M&S

## A. DOD M&S VISION

1. In 1991, the Deputy Secretary of Defense assigned overall management responsibility for all DoD M&S to the USD(A), now the USD for Acquisition and Technology. To assist the USD(A) in managing DoD M&S, the USD(A) established the DoD EXCIMS and granted it oversight and management authority. The USD(A) tasked the EXCIMS to develop a vision for DoD M&S to help focus the DoD's M&S community on core functions. The EXCIMS focused on applying M&S in ways that would enhance overall U.S. military capability.

2. The EXCIMS incorporated these ideas into the DoD M&S vision:

> Defense modeling and simulation will provide readily available, operationally valid environments for use by the DoD Components:
>
> - To train jointly, develop doctrine and tactics, formulate operational plans, and assess warfighting situations.
>
> - To support technology assessment, system upgrade, prototype and full-scale development, and force structuring.
>
> - Furthermore, common use of these environments will promote a closer interaction between the operations and acquisition communities in carrying out their respective responsibilities. To allow maximum utility and flexibility, these modeling and simulation environments will be constructed from affordable, reusable components interoperating through an open systems architecture.

## B. DISCUSSION OF THE VISION

1. The DoD M&S Vision encompasses models and simulations ranging from high-fidelity engineering models to highly-aggregated, campaign-level simulations involving joint forces. It includes all types of models and simulations and embraces the full range of M&S interaction between the scope of the simulation, sponsoring component objectives and functional area requirements (e.g., education, training and military operations; analysis; research and development; test and evaluation; production and logistics). Figure 2-1 illustrates the range of M&S embraced by the DoD M&S Vision. It notes that there are many other perspectives of M&S, including the level of resolution, degree of human participation, degree of physical realism, time-management method, time-step resolution, degree of distribution, and computational complexity.

2. Advanced M&S may integrate a mix of computer simulations, actual warfighting systems, and weapon system simulators. The entities may be distributed geographically and connected through a high-speed network. Warriors at all levels will use M&S to challenge their military skills at tactical, operational, or strategic levels of war through the use of synthetic environments representing every potential opponent in any region of the world, with realistic interactions. Acquisition personnel may use the same synthetic environments for research, development, and test and evaluation activities. M&S will increasingly be used to improve efficiency and effectiveness in engineering development and system design, manufacturing, and logistical support functions. Acquisition personnel will also use synthetic environments to support the acquisition decisionmaking process. Such synthetic environments[1] will be accessible to all appropriate functional users.

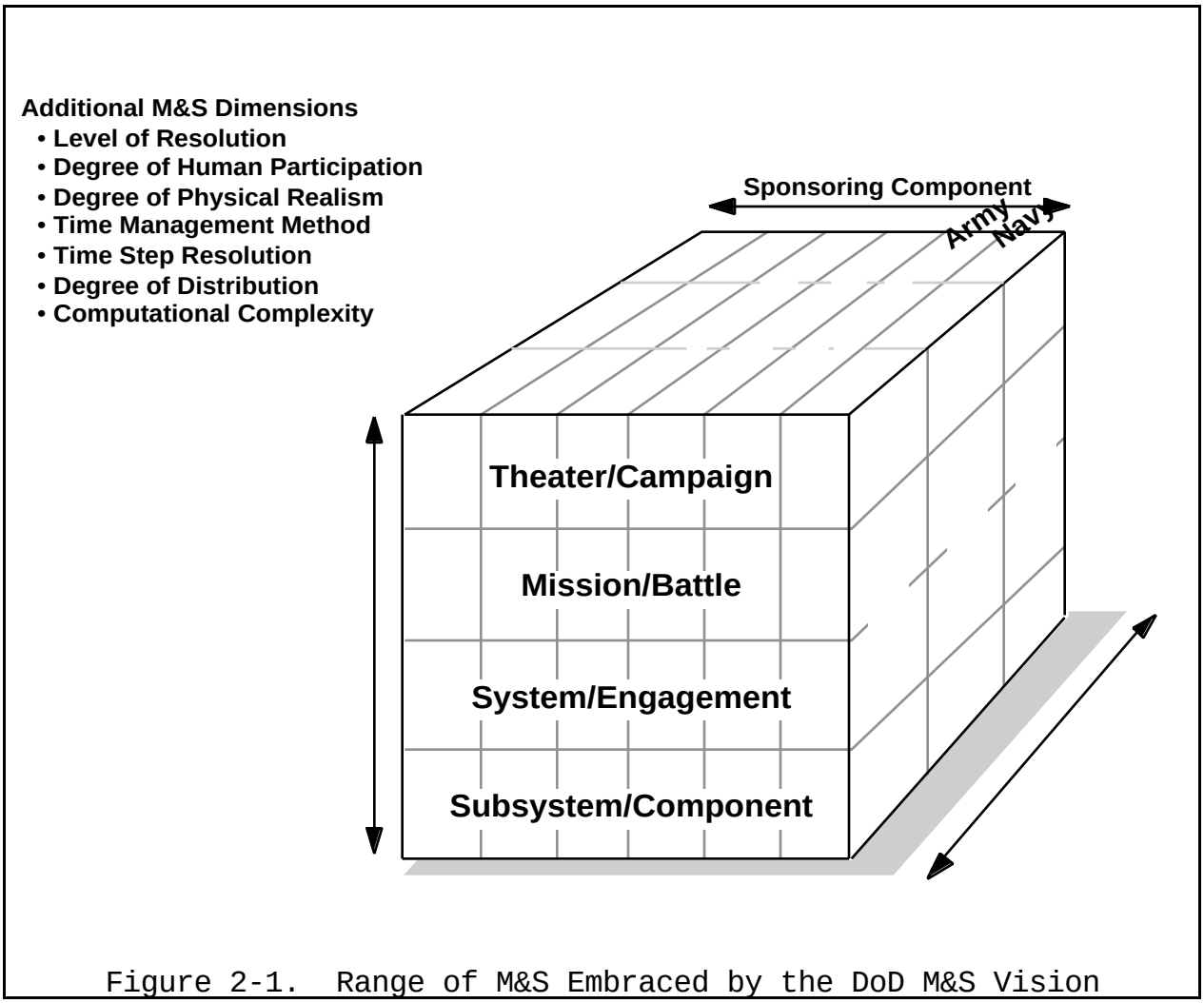



Figure 2-1. Range of M&S Embraced by the DoD M&S Vision

[1] See definition 53.

C. FUTURE M&S SUPPORT TO THE FOUR PILLARS OF MILITARY CAPABILITY

M&S can substantially improve capabilities and decisionmaking in each of the four pillars of military capability: (1) readiness; (2) modernization; (3) force structure; and (4) sustainability. There are very challenging aspects to these descriptions, and achieving full capabilities will require long-term, systematic, coordinated efforts across the Department of Defense.

1. Readiness. M&S will enhance readiness by allowing UCCs and Services to train forces, develop doctrine and tactics, assess performance of units, support planning, execution, and analysis of operations and exercises, evaluate operational plans, conduct "what if" analyses on those plans, rehearse missions, and support analysis of the political, military, and economic dimensions of security for policy development.

a. M&S will allow training to be joint, to involve Active and Reserve forces, to span multiple echelons, and to include computer-generated simulations of large-scale forces in a synthetic environment. Computer-generated forces (friendly, neutral, and hostile) will replace some human participants, allowing the representation of realistic large-scale forces in the synthetic environment controlled by a small number of human commanders. The synthetic environments will be able to bridge large geographic regions worldwide and involve the entire joint force, from senior commanders down to individual soldiers. Trainees will interact with the synthetic environment through their actual "go-to-war" command, control, communications, computers, and intelligence ($C^4I$) equipment and weapon systems.

b. M&S will provide training for the complete spectrum of military operations for all regions of the world and affected regions of space. Exercise and training feedback will be available in near-real-time, with after-action reporting systems and exercise reconstruction systems providing a robust analysis capability.

c. M&S will be used to evaluate readiness, assess warfighting situations, and assist in the development and evaluation of operational plans, doctrines, and tactics. M&S will support planners by providing insights into the effectiveness of theater-level campaign plans, operational-level battle plans, and tactical-level mission plans. Decisionmakers will be able to simulate and evaluate the consequences of alternative courses of action during deliberate and crisis action planning. Automated scenario generation and database construction tools, along with easily accessible M&S resource repositories, will enable models and simulations to be set up on short notice.

d. M&S will allow warfighters and military planners to rehearse missions by immersing the warfighters in a synthetic environment that accurately simulates the anticipated terrain,

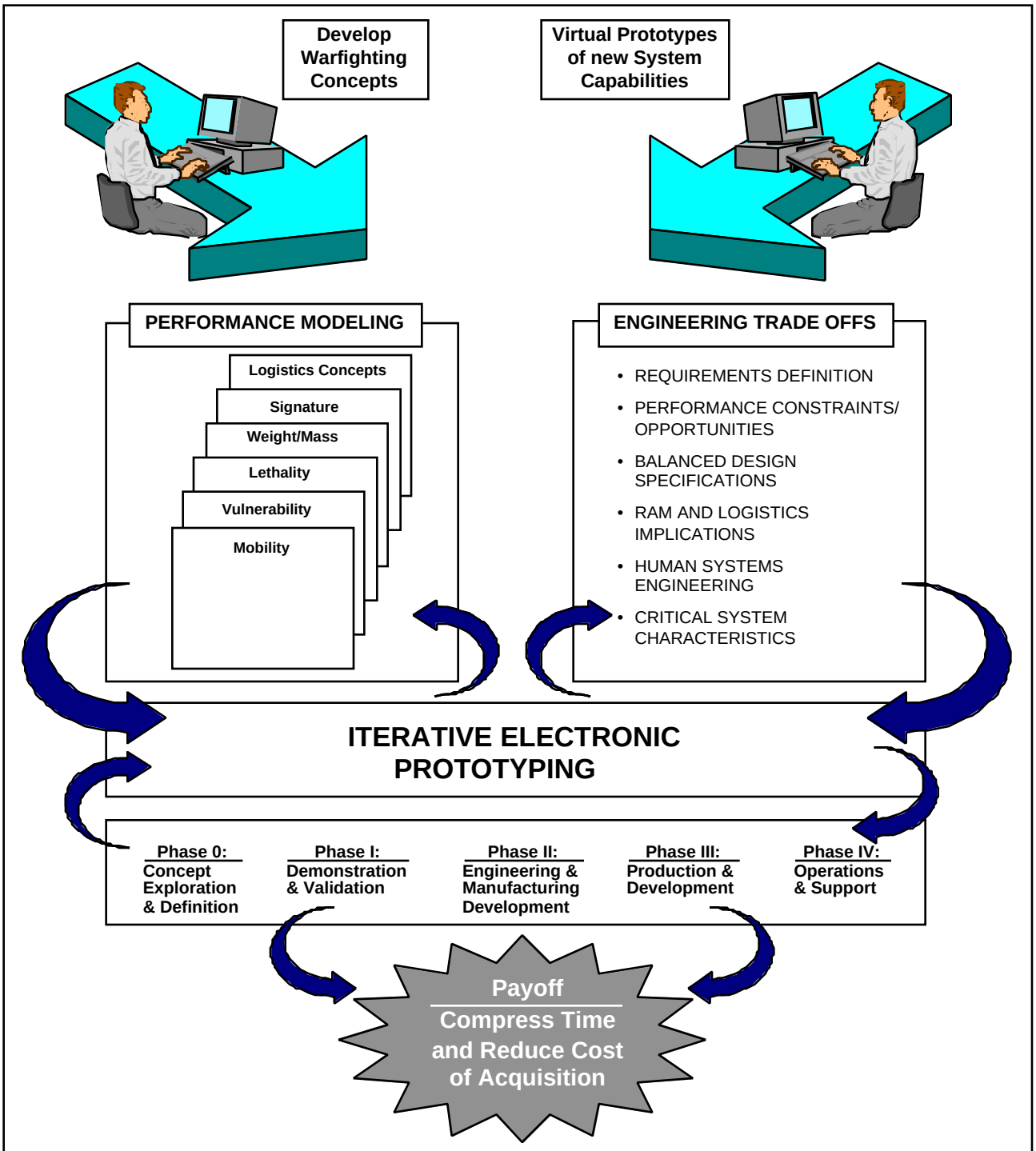
environmental conditions, and threat. This capability will increase the probability of mission success by fostering familiarity and proficiency with the mission plan and it can provide feedback to improve the plan.

e. M&S will provide exploratory and developmental models to support analysis of the political, military, and economic dimensions of national and international security, including the interactions between these dimensions. As they mature, these models will support formulation of national security policy.

2. Modernization. Models and simulations will reduce the time, resources, and risks of the acquisition process and will increase the quality of the systems being acquired. Representations of proposed systems (virtual prototypes) will be embedded in realistic synthetic environments. Such virtual prototypes will support the many phases of the acquisition process from requirements determination and initial concept exploration to the manufacturing and testing of new systems. (See Figure 2-2.)

a. Early operational assessments of new systems and systems upgrades proposed by the government or industry will be examined, within synthetic environments, for their operational and logistical impact prior to milestone I or milestone IV as appropriate. System requirements will be refined. Cost and operational effectiveness assessments will be more accurate and will improve resource allocation decisions. Decisionmakers will be able to compare alternative modernization strategies, using the synthetic environment, to determine which set of new system acquisitions yields the greatest overall mission effectiveness. During system development, continuing evaluations in these synthetic environments will improve engineering trade-off analyses and ensure that the final product optimally satisfies DoD needs.

b. M&S will allow testers to create realistic developmental and operational test scenarios and will improve the test and evaluation planning process. Synthetic environments will allow "dry runs" of planned tests to verify that test conditions can be met with sufficient realism and cost-effectiveness. M&S can be used to focus test objectives resulting in reduced field test assets, resources, test iterations, and test duration. Use of simulation will also allow evaluation of tests otherwise infusible due to limited test resources, environmental restrictions, and/or safety constraints. They will also provide "synthetic" data to exercise the analysis and reporting systems. Virtual prototypes will allow operational testers to conduct early operational assessments in multiple threat environments. Synthetic environments will allow evaluation in environments not reasonably achievable in live testing due to safety or resource limitations. M&S will extend the evaluation of field test results by extrapolating to conditions beyond the scope of the field tests and by exploring any identified questionable areas as well as improve the leveraging of data between developmental and operational tester.




**"The foundation of the acquisition process, the operational requirement and its transition into system terms, can be improved through the use of modeling and simulation... Accounting for human performance early in system acquisition improves system capability and enhances the test and evaluation process to predict operational performance."**

**Defense Science Board Report, December 1989**

Figure 2-2. Vision of M&S Support to the Acquisition Process

Weapon systems must be tested against opposing forces that accurately represent the capabilities and characteristics of potential adversary nations to include tactics, doctrine, force mix, and force strength.

c. M&S will enhance information-sharing among designers, manufacturers, logisticians, testers, and users. Virtual representations of the manufacturing process will be used to examine how the manufacturing process must adapt as weapon systems prototypes are changed. Increased dialogue among these groups and the users of the system will promote a closer interaction between the operations and acquisition communities, making both more effective.

3. Force Structure. M&S will give DoD leadership a powerful arsenal of tools to analyze alternative DoD force structures. Using synthetic environments, the effectiveness of different force compositions will be examined in a wide variety of potential mission scenarios (including operations other than war (OOTW)) against various potential adversaries and challenges across the globe and affected regions of space. M&S tools will support such decisions as the number of squadrons to equip with a particular type of aircraft, or be used to provide insights to such fundamental issues as the optimum roles, missions, size, and composition of each Service.

4. Sustainability. High-fidelity models of logistics will be integrated with combat models to allow for the analysis of combat sustainability; to study the effects of organization size, basing, and doctrine on the logistics infrastructure; and to determine the implications of alternative materiel management, maintenance, and resourcing policies. System logistics and maintenance demands will be assessed to provide a realistic view of system life-cycle support requirements and costs.

## D. ACTIVITY MODEL FOR TRANSFORMING THE VISION INTO REALITY

The six activities necessary to realize the DoD M&S Vision are identified in Figure 2-3, with their related sub-activities noted. This node-tree model provides the EXCIMS and DoD Components with a useful management tool for stating objectives, choosing metrics, and making organizational decisions.

1. Provide Management, Policy & Guidance. Each DoD Component publishes appropriate directives, establishes organizations to support its M&S activities, and develops plans and budgets to satisfy the M&S needs of its Active and Reserve components as well as those of the Unified Combatant Commands and other DoD Components. USD(A&T) may assign responsibility for development and maintenance of a specific common or general-use M&S capability to a DoD Component by formally designating the Component as an Executive Agent. The DoD Components may also further their M&S goals

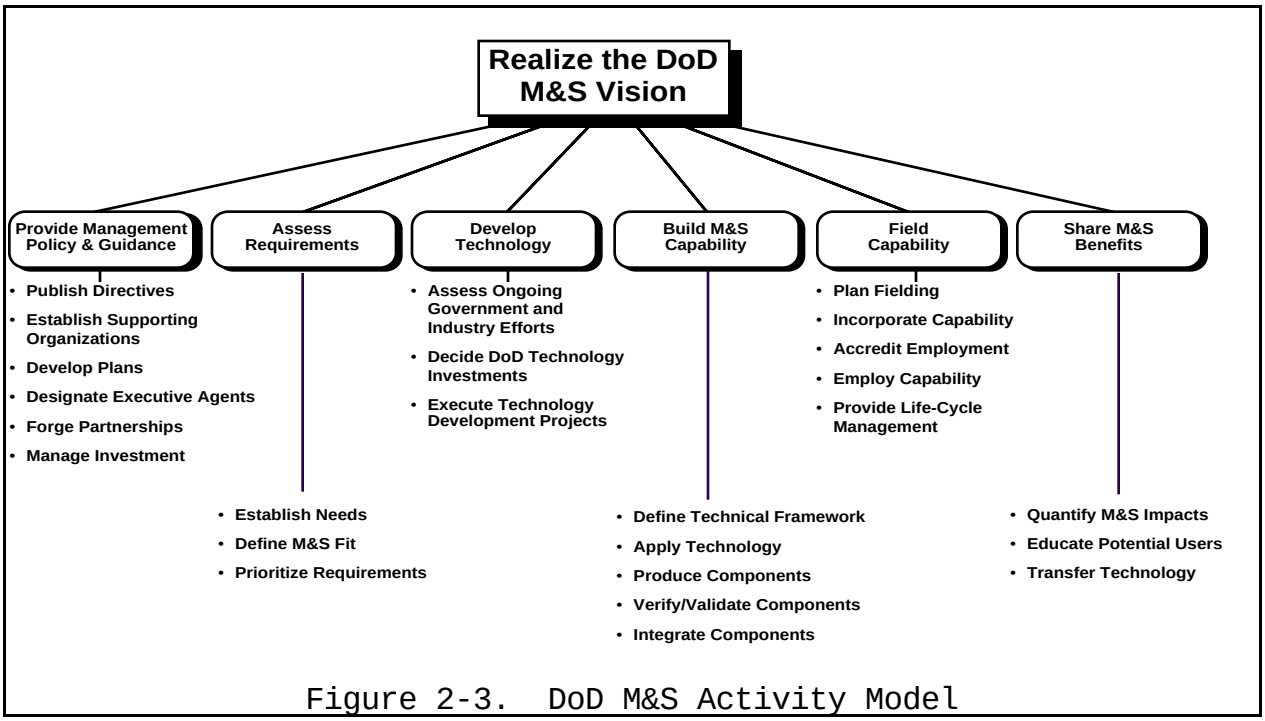



Figure 2-3. DoD M&S Activity Model

by organizing partnerships within their own organizations or with other DoD Components to address common interests. Each Component must make prudent investments to achieve DoD's M&S objectives.

2. Assess M&S Requirements. The needs of all DoD users must be identified and an assessment must be made to determine the potential and cost-effectiveness of M&S to satisfy the needs. The resulting M&S requirements must be prioritized for use in program planning, budgeting, and execution.

3. Develop Technology. It is necessary to continually monitor ongoing industry and government technology developments and assess the risk and cost-benefit of the technologies to support the requirements of the DoD Components for M&S. The technology shortfalls must be identified and priorities must be developed for DoD investments to exploit technology advances in a timely manner, accelerate technological development, fill technology gaps, and rapidly insert the acquired technology into M&S applications. The Director of Defense Research and Engineering's (DDR&E) Technology Area Plan and M&S Technology Area Review/Assessment are central facets of this activity.

4. Build M&S Capability. A technical framework must be developed to ensure appropriate interoperability across different simulations; reuse of simulation components; insertion of new technologies; and flexibility to respond to changing requirements. Then the DoD Components must employ the necessary technology to build the M&S representations (e.g., entities, applications and systems) and ensure they are populated with certified data. These

representations must then be verified, validated, and integrated to provide a useful M&S capability.

5. Field the Capability. The DoD Components must plan the fielding of required M&S applications and systems. The required staffing, communications, data, and management infrastructure must be provided; the M&S software and/or systems must be delivered to the users; and the users must be properly trained in their use, including how to make accreditation[2] and certification[3] decisions. Users will then employ the M&S capabilities to improve readiness, support modernization, and support force structure and sustainment decisions. Configuration Management policies will ensure consistent, compatible M&S usage across the DoD Components.

6. Share the Benefits of M&S. The optimal use of M&S across the Department of Defense will not occur unless the positive (and negative) impacts and cost-effectiveness of M&S are documented and communicated. The DoD Components must educate potential user communities on the existing and expected benefits of M&S employment so that they may make informed investment decisions. This education may include a wide variety of means, such as on-line information systems, seminars, live demonstrations, formal courses of instruction, etc. Where authorized and cost-effective, the Department of Defense must aggressively pursue the exchange of M&S-related requirements, concerns, ideas, and technology among the DoD Components, other Government Agencies, academia, industry, and allied nations.

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[2] Accreditation is the official certification that a model or simulation is acceptable for use for a specific purpose.

[3] Certification is the official approval that M&S data have a specified level of quality or as being appropriate for a specified use, or range of uses.

# CHAPTER 3

# BASELINE ASSESSMENT OF DoD M&S

## A. INTRODUCTION

1. Before 1990, DoD M&S was fragmented and uncoordinated across key communities (e.g., between DoD Components and across functional communities). In recognition of these deficiencies, Congress directed the Department of Defense to "...establish an Office of the Secretary of Defense (OSD) level joint program office for simulation to coordinate simulation policy, to establish interoperability standards and protocols, to promote simulation within the military departments, and to establish guidelines and objectives for coordination [sic] of simulation, war-gaming, and training." (Senate Authorization Committee Report, reference (b)). Consistent with this direction, the DMSO was created, and shortly afterwards key DoD Components designated organizations and/or points of contact to facilitate coordination of M&S activities within and across their communities. As a consequence, there is better sharing of information, capabilities, and resources within and among key DoD M&S communities. However, most users still lack the M&S services they desire. Many potential M&S applications (e.g., Command and Control Warfare (C2W), logistics, OOTW, space systems, manufacturing and C4I) have not been addressed adequately, and major technical challenges loom ahead.

2. These institutional changes facilitated significant advances in M&S in four areas: architectures, standards, and protocols; representation of the environment, systems, and human behavior; fielding of M&S and associated infrastructure; and outreach activities. Nonetheless, major shortfalls that warrant concerted actions by the Department of Defense persist in each of these areas. This is to be expected in so ambitious an effort as is required to realize the DoD vision for M&S.

## B. ARCHITECTURES, STANDARDS, AND PROTOCOLS

1. Two recent Defense Science Board (DSB) Task Forces (Reports on Advanced Distributed Simulation and Readiness, references (c) and (d)) have recommended that architectural[4] efforts to combine live[5], virtual[6], and constructive[7] simulation be broadened. In addition, recent special studies have noted the need for architectural activities to promote the interoperability and reuse of models and simulations to support other functional areas such as acquisition (Report on M&S, reference (e)). Interoperability

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[4] See definition 4.

[5] See definition 35.

[6] See definition 58.

[7] See definition 12.

and reuse are limited because the Department of Defense lacks a common technical framework for simulation architecture. There is now a consensus that DoD must establish such a framework to facilitate the interoperability of all types of models and simulations among themselves and with C4I Systems, as well as to facilitate the reuse of M&S components.

2. Recent efforts have built upon the foundation established by the Advanced Research Projects Agency (ARPA) in the Simulation Network (SIMNET) program to develop Distributed Interactive Simulation (DIS) standards and protocols (e.g., Institute of Electrical and Electronic Engineers (IEEE) Standard 1278). The DIS protocols and standards establish a common data exchange environment, also known as a common messaging environment, using Protocol Data Units, that supports the interoperability of heterogeneous, geographically-distributed, live, virtual and constructive simulations. A strength of the DIS standards development process is its open forum, with broad participation of representatives from government, industry, and academia. The potential exists for DIS to satisfy a broader set of needs than it does today. There is a need to significantly expand DIS and evolve its architecture to support a broader range of capabilities (e.g., to reflect dynamic changes in the environment, support simulations with different time management methods, represent command and control more realistically, and to reduce its computational and communication bandwidth demands (e.g., by switching from its heavy reliance on broadcast). With the anticipated correction of these problems, DIS is expected to serve a central role in the evolution of DoD M&S capabilities.

3. In the area of constructive war games, a 1988 DSB Task Force on Computer Applications to Training and Wargaming (Report on Computer Applications to Training and Wargaming, reference (f)) observed that most constructive simulations used by the Services for training were not interoperable and recommended that steps be taken to redress this shortfall. In partial response, ARPA developed the Aggregate Level Simulation Protocol (ALSP) to interconnect theater-level constructive simulations (Aggregate Level Simulation Protocol, reference (g)). The resulting confederation of Service simulations (e.g., Corps Battle Simulation; Air Warfare Simulation; Research, Evaluation, and System Analysis) has been assembled and used with success in supporting a wide spectrum of joint and combined training exercises (e.g., ATLANTIC RESOLVE, UNIFIED ENDEAVOR, ULCHI FOCUS LENS). ALSP confederations will remain a cornerstone of joint force-level training until the Joint Simulation System reaches Initial Operating Capability. Because the ALSP confederation simulations were originally developed in isolation, they have only limited interoperability, take a long time to set up, and require many people to operate.

4. Recent applications of M&S to train Joint and Service staffs have highlighted the need to interface simulations with $C^4I$ systems. The current generation of simulations is designed with

unique computer workstations as the primary means for the user to interface with the simulation. This presents an unrealistic training environment to the warfighter and requires specially trained personnel to operate the workstations and to interact with the training audience. Interfacing simulations with real-world systems is necessary to enhance training capabilities and facilitate the use of M&S to support real-time operational decision-making.

5. Security is a significant concern in DoD M&S. The conduct of distributed simulations of real-world operations has heightened community awareness of multi-level security (MLS) needs. Progress has been made in the development of encryption and/or decryption devices for the transfer of classified data among distributed sites. However, current security capabilities drive the M&S community to the conduct of system-high exercises[8]. The throughput limits of current encryption devices limit the scale of simulation exercises, and current efforts to address the needs of MLS and multiple communities (e.g., U.S. ONLY, U.S./North Atlantic Treaty Organization, U.S./Republic of Korea) are inadequate. In addition to technical problems, there are also several security policy issues (e.g., disparate security classifications of training simulations among the Services, use of cryptographic equipment by allies) that must be addressed.

6. Data standards, data quality, and data security requirements are an essential part of the M&S technical framework. The DMSO has been designated the Functional Data Administrator (FDAd) for the M&S community . The M&S FDAd has submitted the first Data Administration Strategic Plan (DASP) (reference (h)). Under MSWG sponsorship, a Data and Repositories Technology Working Group (DRTWG) consisting of more than one hundred representatives, has developed a well-defined set of needs and plans for the M&S community. A standard set of data administration policy and procedures needs to be developed for the M&S community to address such subjects as complex data[9] (e.g. probability hit/kill, images, road networks); the verification, validation, and certification (VV&C) of data; authoritative data sources; and data security.

## C. REPRESENTATIONS OF THE ENVIRONMENT, SYSTEMS, AND HUMAN BEHAVIOR

The representations of the environment, systems, and human behavior, along with the processes by which these representations interact, are, at present, shared inadequately across the DoD M&S community.

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[8] System-high exercises require that the entire exercise be classified at the highest level of classified information that is used in the exercise.

[9] See definition 10

1. Representation of the Environment. Impressive representations of the terrain have been achieved, but these databases are largely non-reusable by different simulations and take too much time, money and people to produce. A recent DSB Task Force (Report on Advanced Distributed Simulation, reference (c)) recommended that "DoD must continue research and development (R&D) and maturing activities for reusable terrain and environmental databases." In addition, several operational users have called for the development of the capability to generate environmental representations rapidly, to satisfy operational planning and mission rehearsal requirements. The DMA has implemented a Digital Production System that has begun the process of automating the production of mapping, charting, and geodesy databases. Further progress in the representation of the environment across the Department of Defense is impeded by the lack of:

a. A clear articulation of M&S community requirements for environmental data;

b. A coherent management structure; and,

c. An assured, stable, quality development process on which program managers can depend.

These shortfalls have been highlighted by a recent DSB Task Force (reference (d)), which identified them as major impediments to achieving desired levels of readiness.

2. Representation of Systems. The M&S community is exploring the development of authoritative models for representing military and non-military systems and units as a means of enhancing interoperability and reuse. As examples, the Army is developing a functional description of the battle space to assist in the development of object representations; the Air Force has developed an object-oriented environment; efforts are underway to develop a joint warfare simulation object library; and Defense Intelligence Production Centers are developing common approaches for representing threat forces and systems. However, at present, there are no broadly accepted community standards for representing military systems and organizations in M&S. Consequently, representations of the same system in different models are frequently incompatible. Shared community standards are required for the promises implicit in object oriented models to be realized. Once these standards have been developed and implemented, the level of effort associated with the generation of these products is still projected to be quite high. In several cases (e.g. representation of $C^4I$ systems and electronic warfare environments), additional research and development will be required to understand how they can be modeled authoritatively. Consequently, a substantial long-term investment will be needed to achieve a fully populated set of system representations.

3. Representation of Human Behavior. The fully and semi-automated authoritative representations of friendly or threat forces (Report on Advanced Distributed Simulation, reference (c)) and other groups of humans under the stresses of conflict (Final Report of the Acquisition Task Force on M&S, reference (e)) are widely recognized as exceedingly challenging tasks. To respond to these challenges, the Department of Defense has undertaken two key R&D initiatives. The U.S. Army's Modular Semi-Automated Forces (ModSAF) program is attempting to provide a baseline, standardized, modular software structure in which model components have well-defined and documented interfaces. This structure is being implemented so that model behavior can be reconfigured in run-time. The program is also seeking to develop more sophisticated, generalized representations of behaviors, missions, and behavior control mechanisms. In its Command Forces program, ARPA is also developing technology to represent command and control in entity-based—simulations. However, there have been few efforts, to date, to represent tactical behavior authoritatively in operational programs. The Army's Close Combat Tactical Trainer program is a notable exception, in which the program manager began with user requirements, identified and collected the relevant behavior from subject matter experts, and developed authoritative representations of tactical behavior. In general, however, the representation of humans in models and simulations is extremely limited, particularly in the representation of opposing forces and their doctrine and tactics. In view of the limited theoretical underpinnings in this area, this issue will require extensive research before human behavior can be modeled authoritatively.

D. FIELDING OF M&S AND ASSOCIATED INFRASTRUCTURE. To realize fully the benefits of widespread usage of models and simulations, attention must be paid to the fielding of M&S systems, verification[10], validation[11], and accreditation[12] (VV&A), M&S data VV&C, resource repositories, communications, and exercise management.

1. Fielding of Systems. In the past, the fielding of M&S systems has been designed to meet only the needs of the developing Component. To achieve the DoD M&S vision, Components developing M&S capabilities must design the systems to:

a. Be interoperable and reusable;

b. Support the operational needs of both active and reserve components;

c. Support the needs of the Commanders in Chief;

d. Address the full range of Defense missions; and

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[10] See definition 56.

[11] See definition 55.

[12] See definition 1.

e. Field M&S systems in adequate numbers to meet DoD-wide end-user needs. DoD operational requirements must be identified and an adequate plan must be developed to meet expected needs.

2. VV&A/VV&C. DoD Directive 5000.59 (reference (a)) directs each of the DoD Components to develop an approach to VV&A that is appropriate to the models and simulations within its purview. Consistent with this direction, some DoD Components have defined approaches to VV&A (e.g., Department of the Army Pamphlet 5-11, reference (i)). Emphasis on M&S credibility has stimulated V&V activities to begin much earlier in model development and to become part of the M&S life cycle. Likewise, more discipline is being introduced into documentation of V&V activities that support accreditation. However, it is widely acknowledged that there are several issues that must be resolved before VV&A can be regarded as a well-defined, routine process. First, the procedures for verification and validation (V&V) of new models, or of models used for new mission areas, need to be refined. Particular attention must be given to the issue of the relative costs and benefits associated with increasing levels of V&V (i.e., how much V&V is enough?). Second, efforts are needed to develop tools to support VV&A and to provide training in their use. Efforts are also required to build automated VV&A tools to assist exercise and/or application designers as they are uniquely configuring their distributed simulations. Finally, procedures for accreditation need to be matured. In view of the criticality of the VV&A process, these activities warrant high priority community action. Data VV&C as part of the M&S VV&A process is essential to ensure credibility of M&S results.

3. Resource Repositories. Today, the Department of Defense does not have a robust, integrated system for sharing and maintaining models, simulations, data, metadata, algorithms, and tools. The M&S community has a requirement for a networked, distributed MSRR system to address its needs in this area. The DISA is developing a DoD Repository System (DDRS), of which an MSRR would be a sub-set. In coordination with DISA efforts, the DRTWG is developing a plan to identify requirements, design, and prototype an MSRR consistent with DISA's next generation DDRS. The objective of the DRTWG’s efforts is to develop unclassified and classified (secret system high) distributed systems to serve M&S clients in developing and using M&S and accessing and retrieving data.

4. Communications. A reliable communications infrastructure with capacity adequate to support M&S does not yet exist. However, promising efforts to provide the special M&S communications needs are under way. The Defense Simulation Internet (DSI) has been implemented to support the needs of geographically distributed users. An ARPA/DISA Joint Program Office manages the DSI, and plans have been made to merge DSI with the Defense Research and Engineering Network (DREN) and to enhance the capacity and reli

ability. The long-term objective is to use commercial services and operational communications capabilities to meet M&S needs. Additional challenges include the need for additional features (e.g., dynamic multicasting), latency reduction, bandwidth reduction, improvements in security, and expanded use of commercial communications.

5. Exercise Management. Recent experience in conducting large distributed M&S exercises (e.g., ATLANTIC RESOLVE, UNIFIED ENDEAVOR, ULCHI FOCUS LENS 94, Synthetic Theater of War-Europe (STOW-E)) has highlighted the challenge of M&S management. In the future, the use of M&S capabilities by all Components will produce competition for resources and must meet the needs of the entire DoD M&S community. To facilitate the increased use of distributed M&S capabilities the Department of Defense must provide improved management of M&S assets and access to expertise in the planning and conduct of distributed M&S exercises.

E. OUTREACH ACTIVITIES

1. There has been a dramatic increase in the level of outreach activities that have been undertaken to enhance cross-community coordination, technology transfer, and exchange of information. These include increased participation at key conferences (e.g., demonstration of the ability to link heterogeneous virtual simulations at the Interservice and/or Industry Training Systems and Education Conference), increased interface efforts through professional societies (e.g., mini-symposia on VV&A and simulation data sponsored by the Military Operations Research Society; workshops on $C^4I$ and M&S sponsored by the American Institute of Aeronautics and Astronautics; and the Intelligence Community M&S Coordinating Group's annual symposium), extended international involvement (e.g., increased efforts to address the development and application of international M&S standards among allies), creation of the Industry Steering Group on M&S, and active promotion of dual-use of DoD M&S technologies (e.g., participation on inter-agency task forces to expand the use of M&S technology in civilian education and training).

2. A number of task forces have called for an extended outreach program. Several of these task forces have recommended initiatives to educate and train key communities on the capabilities and appropriate uses of M&S (Report on Advanced Distributed Simulation and Report of the Acquisition Task Force on Modeling and Simulation, references (c) and (e)). In addition, a White House-led Task Force on Learning and Technology recommended that an extensive demonstration program be undertaken to promote dual-use and to better communicate the benefits of M&S in education and training.

3. Some elements of the Department of Defense and Congress have voiced skepticism about the return on investment associated

with the development and use of M&S. Among the issues is the

concern that models and simulations require extensive investments that compete for the limited funds that are available for training and acquisition activities and the fear that the more extensive use of models and simulations will come at the expense of traditional training approaches (e.g., field training exercises, flight time). To address this problem, the M&S community must demonstrate to potential users that the capabilities and benefits that M&S provide are more than commensurate with the investment required. Initial estimates strongly suggest that the effectiveness and cost of M&S are highly favorable for many applications in the Department of Defense (e.g., training, acquisition, mission rehearsal), but more active efforts must be undertaken to collect and interpret the required data and to make such results available in credible form to senior decision makers.

F. SUMMARY

1. In general, today's simulations:

a. Are narrowly focused, stove-piped developments for each user community.

b. Do not fully meet active, reserve or joint needs.

c. Take too long to build.

d. Cost too much to build and operate.

e. Have not been verified, validated and accredited.

f. Are not interoperable with other M&S assets that could be useful.

g. Are not easily maintainable or extensible.

2. However, there has been a substantial increase in the attention and emphasis placed on M&S in the Department of Defense. Many excellent programs are underway and there is now a consensus on the need to interoperate and reuse models, simulations, and related products across DoD Component lines, across traditional communities (e.g., linking models and simulations to $C^4I$ systems), across functions (e.g., sharing capabilities between operations and acquisition), and across classes of models and simulations (e.g., linking live, virtual, and constructive simulations).

There is an opportunity to create simulations tailored to the user's need, at a greatly reduced cost in both time and money, and with elements of proven quality. Patience, perseverance, and significant investment are required to overcome many challenging problems, but the potential payoff in military capability is extremely high.

# CHAPTER 4

## DOD M&S OBJECTIVES

A. INTRODUCTION. The baseline M&S assessment and an analysis of the activities described in the DoD M&S activity model identified many shortfalls that must be corrected to realize the DoD M&S vision. The set of actions outlined here are designed to efficiently encourage early and continued use of M&S in accord with the vision. Six DoD-wide objectives were derived by the logic depicted in Figure 4-1. M&S applications are found though-out the Department of Defense. A single model or simulation can fulfill only a modest set of needs. Therefore, the objectives do not speak, per se, to any specific application whose contents are driven by application needs. Instead, the objectives address those aspects of M&S that may be common and which will ensure interoperability where appropriate. For each objective, this plan_

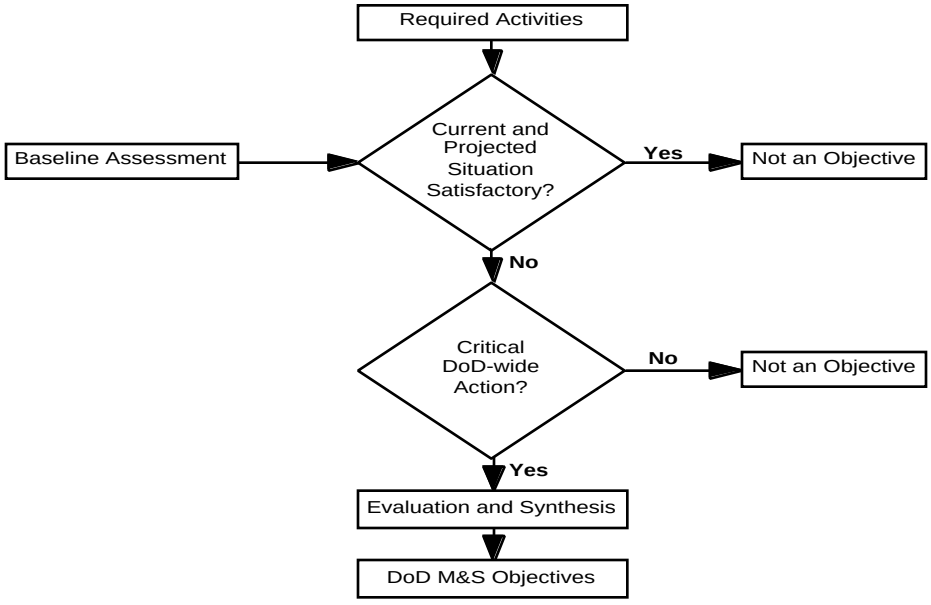


Figure 4-1. Logic for Deriving M&S Objectives

identifies key issues and actions. Achieving these objectives will take significant time and resources, and require a DoD-wide coordinated effort. Figure 4-2 shows the six objectives and the breakout of the objectives into sub-objectives. The following sections discuss each objective and sub-objective and identify the major issues and actions that the Department of Defense needs to take to accomplish each objective and/or sub-objective. Where assigned, the DoD organization with primary responsibility (PR) for each action is also identified.

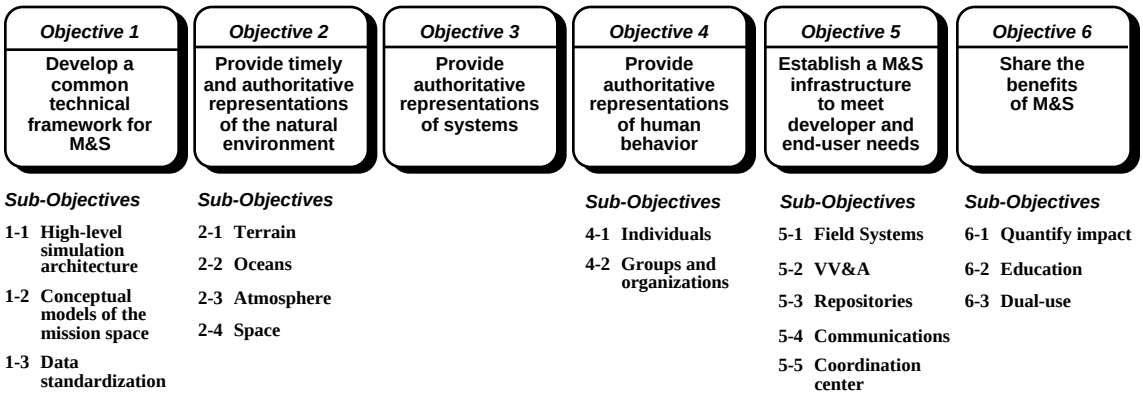


Figure 4-2. DoD M&S Objectives and Sub-Objectives

B. OBJECTIVE 1. Provide a common technical framework for M&S.

1. Discussion. The efficient and effective use of models and simulations across the Department of Defense requires a common technical framework for M&S to facilitate interoperability and reuse. The technical framework will consist of: a common high-level architecture (HLA) to which models and simulations must conform; conceptual models of the mission space (CMMS) to provide a basis for the development of consistent and authoritative simulation representations; and, data standards to provide common representations of data across models, simulations, and C4I systems.

2. Sub-Objective 1-1. Establish a common high-level simulation architecture to facilitate the interoperability of all types of simulations among themselves and with C4I systems, as well as to facilitate the reuse of M&S components.

a. Discussion. No single model or simulation system can satisfy all uses and users. To facilitate the interoperability of models and simulations as well as to allow maximum reuse of their components, the DoD requires a HLA to which simulations developed by particular DoD Components or functional areas must conform. Further definition and detailed implementation of specific simulation system architectures will remain the responsibility of the developing Component[13]. The HLA will specify only the minimum definition required to facilitate interoperability and reuse. The primary components of the HLA include:

[13] For example, both the Joint Simulation System and the Close Combat Tactical Trainer would both conform to the HLA, but each would also have its own more specific system architecture for purposes of implementation.

(1) Functional Definition. A set of rules which describe the functions of simulations and the services provided by the runtime infrastructure in HLA federations.

(a) Simulation Functionality. The HLA requires simulations to furnish the external functionality necessary to interact with other simulations via the runtime infrastructure according to the interface specification. The HLA makes no specification about the internal structure of simulations.

(b) Runtime Infrastructure Services. The runtime infrastructure software provides the services that allow simulations to form federations and exchange information with one another. The HLA prescribes the nature of these services.

(2) Interface Specification. In the HLA, simulations interact with a runtime infrastructure to establish and maintain a federation and to enhance information exchange among simulations. The HLA contains an interface specification that defines the nature of these interactions.

(3) Object Model Template. The HLA requires simulations and sets of interacting simulations ("federations") to each have an object model describing the entities represented in the simulations and across the federation. The HLA object model template prescribes the kind of information that should be included in the object models, but it does not define the object classes (e.g., vehicles, unit types) that will appear in the object models.

b. Issues:

(1) Process for defining, evolving, and maintaining the HLA, recognizing that no one party can represent all issues.

(2) Improved cost-effectiveness of DoD M&S by ensuring broader accessibility of widely needed capabilities (e.g., entity and unit representations, environmental databases).

(3) Adoption of architectural constructs to facilitate the reuse of all classes of M&S across all functional areas (e.g., training, analysis, and acquisition), without unduly restricting the flexibility of individual M&S projects.

(4) Development of M&S interfaces with current and emerging $C^4I$ systems to allow operators to input data to models and simulations and to receive output from them in real-world format at live $C^4I$ systems in support of a full spectrum of applications (e.g., campaign planning, mission planning, command post exercises, and battle management training).

(5) Identification of the full set of interfaces for which standards are required.

(6) Synchronization of models and simulations that employ different time-management methods.

(7) Adaptation of the DIS architectural concepts and standards to the HLA as DIS evolves.

(8) Reconfiguration of simulations to address new requirements.

(9) Extent to which security can be addressed in the HLA (rather than just in the treatment of individual simulations and federations of simulations).

(10) Establishment of procedures to ensure compliance with the HLA.

c. Actions:

(1) Establish an Architecture Management Group (AMG) by second quarter fiscal year (FY) 1995. The AMG will be formed from DoD parties with major interests in M&S and modeled after open, consensus-based commercial approaches (e.g., Internet Architecture Board, Object Management Group). For practical purposes, the AMG will first be formed as a small group drawn primarily from representatives of those programs that have a commitment to implementing the HLA and testing and refining it with prototypes. (PR: DDR&E)

(2) Develop alternative high-level architectural concepts by second quarter FY 1995, drawing on architectural development efforts already ongoing in DoD programs. (PR: DDR&E)

(3) Develop an initial description document for a common HLA by second quarter FY 1995. (PR: DDR&E)

(4) Coordinate with DIS standards bodies in FY 1995 to encourage the rapid evolution of DIS architectural concepts and standards to meet DoD needs. (PR: DMSO)

(5) As a step in facilitating the interoperation of M&S with $C^4I$ systems, evaluate the suitability of the HLA data exchange environment as a means to link M&S with $C^4I$ systems by fourth quarter FY 1996. (PR: DMSO)

(6) Identify M&S security requirements (e.g., speed of encryption, security management infrastructure, use of U.S. cryptographic equipment by allies, MLS) to appropriate development agencies in FY 1995, and work with them to establish interim solutions and standards. (PR: DoD C3I Authorities)

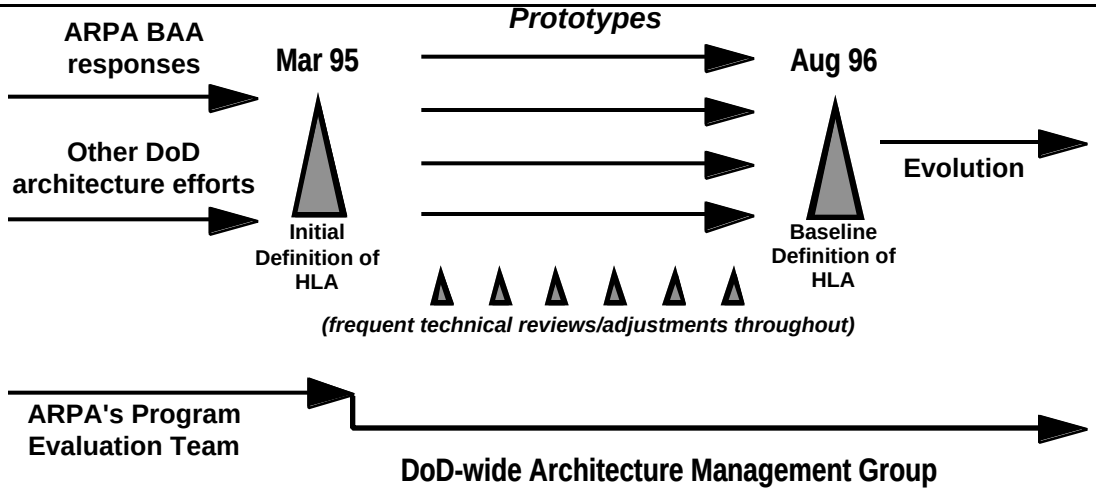


Figure 4-3. HLA Definition Process

(7) Develop prototypes by third quarter FY 1996 for implementing and testing the HLA (from action B.2.c.(3), above). (PR: AMG)

(8) Evaluate the prototypes and baseline the HLA definition by fourth quarter FY 1996. The full process from alternative concepts to architecture definition (Actions B.2.c.(2), B.2.c.(3), B.2.c.(7), and B.2.c.(8)) is illustrated in Figure 4-3. (PR: AMG)

(9) Begin providing in FY 1995 supporting software usable by programs conforming to the HLA. (PR: AMG)

(10) Establish a common technical means by fourth quarter FY 1996 to test compliance with the HLA. (PR: AMG)

(11) Review all ongoing DoD M&S projects and/or programs by second quarter FY 1997 for feasibility of immediately adopting the HLA. If not immediately feasible, these reviews shall establish the date by which each program shall comply. If a specific M&S project and/or program is unable to comply with the HLA, the developing Component must report the reason(s) for non-compliance to the DDR&E. (PR: DoD Components)

(12) Establish an oversight mechanism by second quarter FY 1997 to monitor M&S program progress towards compliance with the HLA. (PR: USD(A&T))

(13) Establish a process in FY 1995 for discussing architectural and related issues with the outside community; i.e., defense industry, the commercial sector, and academia. (PR: DMSO)

3. Sub-Objective 1-2. Develop conceptual models of the mission space (CMMS) to provide a common starting point for con

structing consistent and authoritative M&S representations, and to facilitate interoperability and reuse of simulation components.

a. Discussion. The CMMS is a first abstraction of the real world and serves as a frame of reference for simulation development by capturing the features of the problem space. Those features are the entities involved in any mission and their key actions and interactions. The CMMS is a simulation-neutral view of the real-world, and acts as a bridging function between the warfighter, who owns the combat process and serves as the authoritative source for validating CMMS content, and simulation developers. Additionally, the CMMS provides a common viewpoint and serves as a vehicle for communications among warfighters, doctrine developers, trainers, C4I developers, analysts, and simulation developers. Such a foundation allows all concerned parties to be confident that DoD simulations are founded in operational realism.

(1) The simulation development process diagrammed in Figure 4-4 depicts a flow from the real world to simulation, a software representation of that world. Each simulation developer must start by assembling an understanding of how the operating forces perform their mission. This process is accomplished each time a simulation is developed. The developer performs a front-end analysis of the problem space, selecting the aspects of the real world to be represented and their resolution. While in the design phase, having selected those important aspects of the real world to model, the developer iterates back to the real world for additional information (e.g., greater detail, sequences, time to perform).

(2) Currently, there are two serious problems with the manner in which this simulation development process is executed: 1.) different developers rely on different sources for the same information, yielding inconsistent pictures of the real world, and 2.) the information, obtained at considerable expense, is not maintained for use in future simulations. The CMMS will require reliance on authoritative sources and serve as the means for capturing, sharing, and evolving this information. As an automated representation of the real world, the CMMS will provide a common, easily accessible, authoritative starting point for design activity relating to Objectives 2, 3, and 4, and facilitate interoperability and reuse among simulations.

b. Issues:

(1) Process for further defining, evolving, and maintaining the CMMSs.

(2) Level of detail to which the CMMSs must be developed.

(3) Determination of appropriate classification schema that facilitates information integration and reuse.

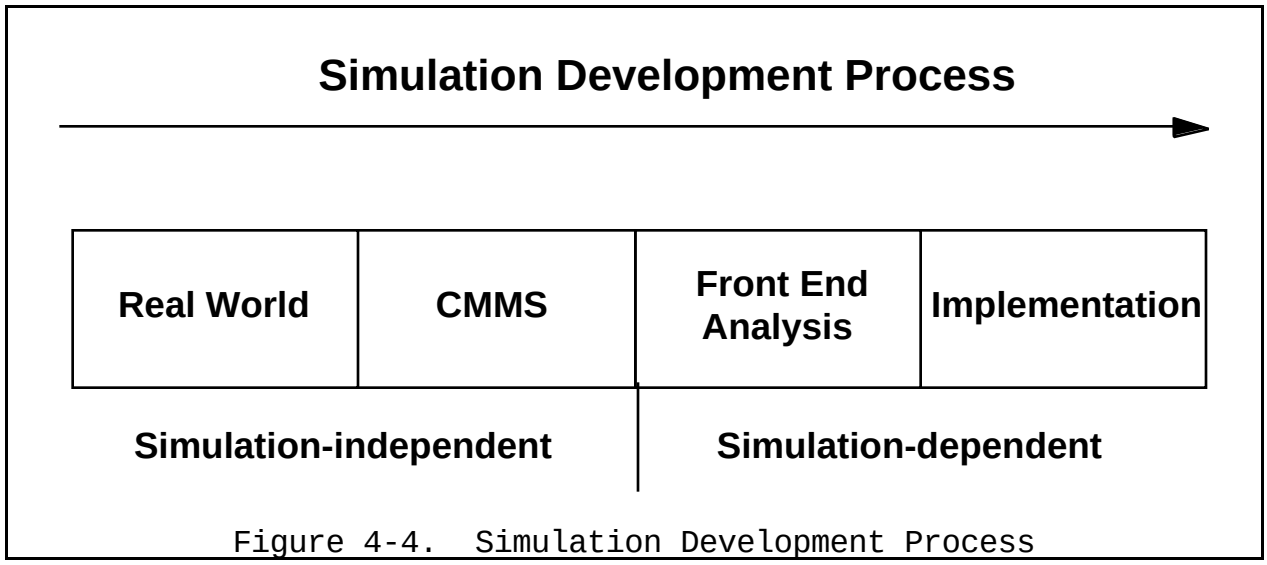


Figure 4-4. Simulation Development Process

(4) Availability of documentation and other authoritative sources describing the mission-space functions.

(5) Development responsibilities and funding.

(6) Requirements to allow distributed development.

(7) Determination of software tools.

(8) Ownership, authentication, and maintenance of CMMS.

c. Actions:

(1) In FY 1995 form CMMS technical support team, conduct research, and begin development of initial CMMS prototype leveraging work from other sources. (e.g., Joint Mission Essential Task List, Universal Joint Task List (UJTL)). (PR: DMSO)

(2) In 1st quarter FY 1996, define CMMS technical framework. (PR: DMSO)

(3) In FY 1996, develop CMMS software environment and support ongoing CMMS activities by simulation developers. (PR: DMSO)

(4) In FY 1996, incorporate existing conceptual models (including process models) into the CMMS as feasible. (PR: DMSO)

(5) Beginning in FY 1996, simulation developers voluntarily build their conceptual models in accordance with the

CMMS technical framework and provide them to DMSO for integration into the DoD-wide CMMS. (PR: Components)

(6) In FY 1997, complete initial version of CMMS, maintain and evolve CMMS on a continuing basis, and support ongoing Component CMMS projects. (PR: DMSO)

4. Sub-Objective 1-3. Establish data standards to support common representations of data in models and simulations.

a. Discussion. Data is critical to M&S. In the data area, the overarching objective is to enable data suppliers to provide the community affordable, timely, verified, and validated data to promote reuse and sharing of data, interoperability of models and simulations, and improved credibility of M&S results. The policies, procedures, and methodologies for data standards form general guidance for data used in environmental, systems and human behavior representations (Objectives 2, 3, and 4, sections C, D, and E).

b. Issues:

(1) The need to establish data standards (e.g., data element definitions, data dictionary, data models, etc.) in compliance with DoD policy.

(2) The lack of DoD guidance on the establishment of data standards for complex data (e.g., probability of hit and/or kill, images, road networks), nomenclature and symbology.

(3) The need to define requirements for supporting data and data standards in the distributed MSRR system.

c. Actions:

(1) Establish data modeling and standardization efforts in the M&S community in compliance with DoD Policy. Ongoing. (PR: DMSO)

(2) Develop extensions to data standards to include nomenclature, symbology, and complex data standards. Issue initial M&S policy and procedures for data standards in FY 1996, complex data standards in FY 1996, nomenclature and symbology standards in FY 1997. (PR: DMSO)

(3) Develop the requirements for supporting data and data standards in the MSRR system by third quarter FY 1996. (See Sub-objective 5-3, subsection F.4.) (PR: DMSO)

C. OBJECTIVE 2. Provide timely and authoritative representations of the natural environment.

NOTE: VV&A, resource repositories, and configuration control are addressed in Objective 5, section F.

1. Discussion. Models of military operations depend on interaction with representations of the natural environment including permanent and semi-permanent man-made features. Further realistic representation of military operations requires integration of weapons effects and resulting environments. This requires authoritative three-dimensional representations of the terrain, oceans, atmosphere, and space to include environmental quality issues (e.g., conservation, pollution prevention). These representations are complex in design and require significant funds and time to build. Therefore, the complexity should be commensurate with the simulation's functional requirement for detail given the scope of what is being modeled. Additionally, environmental representations must be seamless in terrain, ocean, atmosphere, and space boundary regions to present fully integrated data for M&S use. For example, M&S in the littoral region[14] can require high resolution interface between terrain, oceanographic, and atmospheric data and among process models of beach trafficability, local atmospheric effects, tides, waves, surf, and sediment transport. Because resource constraints prevent having current worldwide representations available off-the-shelf, a suitable, cost-effective process must be established to provide "just-in-time" production of these representations.

a. Terrain representation includes the configuration, composition, and representation of the surface of the earth, including its relief, natural features, permanent or semi-permanent man-made features, and related processes. Terrain representation includes terrain coverage including seasonal and diurnal variation such as grasses and snow, foliage coverage, tree type, and shadow. The terrain surface includes inland waters, and the sea floor bottom to the 20 meter depth curve. The representation also includes the mutual interaction of dynamic phenomena and the terrain.

b. Oceanographic representations include data on the ocean bottom (e.g., depth curves and bottom contours) as well as processes required to model the natural and man-made changing surface (e.g., sea state) and sub-surface (e.g., temperature, pressure, salinity gradients, acoustic phenomena) conditions.

c. Atmospheric representations are developed in a zone from the earth's surface to the upper boundary of the troposphere and include:

(1) Particulate and aerosol data on haze, dust, and smoke (to include nuclear, biological, and chemical effects)

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[14] The littoral region is defined as 1) Seaward - the area from the open oceans to the shore that must be controlled to support operations ashore; 2) landward - the area inland from the shore that can be supported and defended directly from the sea.

(2) Data on fog, clouds, precipitation, wind, condensation (humidity), obscurants, contaminants, radiated energy, temperature, and illumination.

(3) Process models for generating, moving, dispersing, and dissipating atmospheric phenomena in four-dimensional (i.e., three-dimensional spatial location over time) representations of both natural and modified environments (to include the effects conventional, nuclear, chemical, biological, and other weapons and/or collateral effects[15])

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d. Ionosphere and space representations are developed beyond the upper boundary of the troposphere. These representations must include data on neutral and charged atomic and molecular particles (including their optical properties) and the processes required to model transatmospheric and exoatmospheric ballistics, orbital dynamics, electromagnetic phenomena, aerospace, and astrodynamic relationships. Effects on satellite and spacecraft performance and communications caused by natural and human induced changes in the geomagnetic field and the presence of charged particles must be portrayed accurately.

2. Sub-Objective 2-1. Provide timely and authoritative representations of the terrain.

a. Issues:

(1) Definition of user community requirements in terms of the required feature data content, levels of resolution, accuracy, and fidelity for terrain representation.

(2) Development of standard, correlated terrain representations at multiple levels of detail.

(3) Availability of source data (e.g., imagery from overhead systems).

(4) Coordination of terrain representation production to reduce costs and improve data consistency and quality.

(5) Development of a cost-effective capability to rapidly produce standardized terrain data to meet Component needs, including the requirements of UCCs to support short-notice operational planning and mission rehearsal.

(6) Development of standard representations of terrain processes (e.g., thermodynamic and hydrologic models, soil strength, slump) and seasonal changes (e.g., foliage, ground cover, and reflectance).

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[15] Weapons and collateral effects environments include both the physical effects resulting from weapon detonations and accidents/incidents potentially associated with the generation, transport, and weapons employment of nuclear, biological, and chemical materials in war and in OOTW.

(7) Development of a capability to represent terrain changes dynamically (e.g., weapons and/or collateral effects, craters, earth moving, damage to structures), and diurnal changes (e.g., illumination, shadows, temperature, and reflectance).

(8) Development of standard methods to link models and simulations that use terrain data of differing resolution.

(9) The production of geo-typical, vice geo-specific, terrain representations for training exercises.

(10) The accessibility and reuse of three-dimensional models of typical cultural features (e.g., buildings, bridges).

b. Actions:

(1) Develop authoritative terrain prototype data sets to support M&S activities. (PR: Executive Agent - DMA)

(a) Select geographic areas for prototyping by the third quarter of FY 1995.

(b) Specify the data resolution levels, fidelity, and accuracy required to support major M&S functional areas in FY 1995.

(c) Develop data dictionaries in FY 1996 for the feature content and attribution requirements of each M&S resolution level.

(d) Define in FY 1996 the data structure, coding and attribution scheme, symbology, and metadata requirements.

(e) Generate prototype terrain data sets over selected geographic areas by second quarter FY 1996.

(2) Once developed, make all terrain representations available to the M&S community through the resource repository system. Initiated in FY 1995. Ongoing. (PR: Executive Agent - DMA)

(3) Demonstrate rapid terrain data generation capability for all specified M&S resolution levels from controlled (all-source) imagery and intelligence sources. (PR: Executive Agent - DMA)

(a) In FY 1995, determine expected availability of source data and develop plans to meet any anticipated shortfall by appropriate liaison. (PR: Executive Agent - DMA)

(b) Select geographic areas and target M&S programs for prototyping rapid terrain database generation in FY 1995.

(c) Demonstrate computer-assisted feature extraction from multiple-source imagery, with data generalization techniques applied to generate multiple database resolution levels from single pass extraction in FY 1996.

(d) Demonstrate an initial capability in FY 1996 to produce, within 1 week, standard terrain data to meet M&S functional area requirements contained within a nominal 2500 $km^2$ area.

(e) Demonstrate in FY 1997 the capability to produce standard terrain data to meet M&S functional area requirements contained within a nominal 2500 $km^2$ area (with three-dimensional terrain, including three-dimensional man-made features, reasonably attributed), within 72 hours.

(4) Nominate data exchange standards to Assistant Secretary of Defense for Command, Control, Communications and Intelligence (ASD($C^3$I)), as required in FY 1996. (PR: Executive Agent - DMA)

(5) Demonstrate the capability to generate and/or receive and apply data updates to standard terrain representations, and document the configuration control process required in FY 1996. (PR: Executive Agent - DMA)

(6) Develop authoritative terrain process representations, to include the interface with atmospheric and oceanographic effects (e.g., littoral regions), for selected M&S functional areas. (PR: Executive Agent - DMA)

(a) Document terrain process representations in existing weapons effects and vehicle mobility models to establish the baseline for subsequent specification of standard terrain process representations in FY 1995. (PR: ARPA)

(b) Establish standard process representations of soil mechanics for weapons effects, engineering earthworks, and ground vehicle mobility in FY 1996.

(c) Establish an enhanced set of standard terrain process representations (e.g., thermodynamic and hydrologic models) in FY 1997.

(7) Develop capabilities for dynamic terrain. (PR: Executive Agent - DMA)

(a) Establish standard capabilities for multi-state objects (e.g., damaged structures, changes in vegetation) in FY 1996.

(b) Establish initial capabilities for dynamic terrain in FY 1997.

(c) Develop standard process representations for dynamic terrain in FY 1998.

(8) In FY 1997, develop a standard methodology for interconnecting simulations (live, virtual, and constructive) that use terrain models of differing resolution. (PR: Executive Agent - DMA)

3. Sub-Objective 2-2. Provide authoritative representations of the oceans.

a. Issues:

(1) Definition of user community requirements in terms of the required data content, levels of resolution, accuracy, and fidelity for ocean representation.

(2) Availability of source data (both bottom conditions, surface data, and the water column).

(3) Development of standard, correlated, representations of the oceans.

(4) Identification and development of coordinated, cost-effective capabilities to produce certified oceanographic data.

(5) Development of authoritative process representations for the oceans to include natural and man-made effects.

(6) Development of a capability to interoperate and scale oceanographic models.

b. Actions:

(1) Determine expected availability of source data and develop plans to meet any anticipated shortfall by appropriate liaison in FY 1996. (PR: Executive Agent - TBD)

(2) Develop authoritative oceanographic prototype data sets to support M&S activities. (PR: Executive Agent - TBD)

(a) Select geographic areas in FY 1996 (as required for littoral region interaction) and oceanographic conditions for prototyping.

(b) Specify the data resolution levels, fidelity, and accuracy required to support M&S functional areas in FY 1996.

(c) Develop data dictionaries for the feature content and attribution requirements of each appropriate M&S resolution level in FY 1996.

(d) Define, in FY 1996, the data structure, coding, and attribution scheme, symbology, and metadata requirements.

(e) Generate oceanographic prototype data sets in FY 1996.

(3) Once developed, make all ocean representations available to the M&S community through the resource repository system. Initiate in FY 1996. Ongoing. (PR: Executive Agent - TBD)

(4) Nominate data exchange standards to ASD($C^3$I), as required in FY 1996. (PR: Executive Agent - TBD)

(5) Demonstrate the capability to generate and/or receive and apply data updates to standard oceanographic databases from multiple sources and document the configuration control process required in FY 1997. (PR: Executive Agent - TBD)

(6) Develop authoritative oceanographic process representations to include the interface with associated terrain and atmospheric effects (e.g., littoral region shoreline, bottom, and wind conditions) for selected M&S functional areas. (PR: Executive Agent - TBD)

(a) Define an initial set of standard and dynamic process representations for the ocean environment in virtual and constructive simulations in FY 1997.

(b) Establish enhanced standard oceanographic process representations in FY 1998.

(c) Define and develop process representations for natural and man-made perturbations on oceanographic representations in FY 1998.

(7) Develop a standard methodology for understanding and managing the effects of interconnecting simulations using oceanographic models of differing resolution in FY 1998. (PR: Executive Agent - TBD)

4. Sub-Objective 2-3. Provide authoritative representations of the atmosphere.

a. Issues:

(1) Definition of user community requirements in terms of the required data content, levels of resolution, accuracy and fidelity for atmospheric representations.

(2) Availability of source data.

(3) Development of standard, correlated, data representations of the atmosphere.

(4) Identification and development of coordinated, cost-effective capabilities to produce certified atmospheric data.

(5) Development of authoritative process representations for the atmosphere to include natural and man-made effects.

(6) Development of a capability to interoperate and scale atmospheric models.

b. Actions:

(1) Determine expected availability of source data and develop plans to meet any anticipated shortfall by appropriate liaison in FY 1996. (PR: Executive Agent - TBD)

(2) Develop authoritative atmospheric prototype data sets to support M&S activities. (PR: Executive Agent - TBD)

(a) Select geographic areas in FY 1996 (as required for littoral region terrain and ocean interaction) and atmospheric—conditions for prototyping.

(b) Specify the data resolution levels, fidelity, and accuracy required to support M&S functional areas in FY 1996.

(c) Develop data dictionaries for the feature content and attribution requirements of each appropriate M&S resolution level in FY 1996.

(d) Define, in FY 1996, the data structure, coding, and attribution scheme, symbology, and metadata requirements.

(e) Generate atmospheric prototype data sets by second quarter FY 1996.

(3) Once developed, make all atmospheric representations available to the M&S community through the resource repository system. Initiate in FY 1996. Ongoing. (PR: Executive Agent - TBD)

(4) Nominate data exchange standards to ASD($C^3$I), as required in FY 1996. (PR: Executive Agent - TBD)

(5) Demonstrate the capability to generate and/or receive and apply data updates to standard atmospheric databases from multiple sources and document the configuration control process required in FY 1997. (PR: Executive Agent - TBD)

(6) Develop authoritative atmospheric process representations to include the interface with associated terrain effects (e.g., littoral regions) for selected M&S functional areas. (PR: Executive Agent - TBD)

(a) Define an initial set of standard and dynamic process representations for the atmospheric environment in FY 1998.

(b) Establish enhanced standard atmospheric process representations in FY 1998.

(c) Define and develop process representations for natural and man-made perturbations on atmospheric representations in FY 1998.

(7) Develop a standard methodology for understanding and managing the effects of interconnecting simulations using atmospheric models of differing resolution in FY 1998. (PR: Executive Agent - TBD)

(8) Develop authoritative representations of conventional, nuclear, chemical, biological, and other weapon effects. Initiate in FY 1996; complete in FY 1998. (PR Executive Agent - TBD)

5. Sub-Objective 2-4. Provide authoritative representations of space.

a. Issues:

(1) Definition of user community requirements in terms of the required data content, levels of accuracy, fidelity, precision, and resolution.

(2) Development of interoperable, internally consistent interfaces with other environmental representations.

(3) Availability and internal consistency of aerospace and astrodynamics source data.

b. Actions:

(1) Determine current availability, expected development schedules, and cost of appropriate source data and develop

plans to meet any anticipated shortfall through appropriate liaison by FY 1997. (PR: Executive Agent - TBD)

(2) Develop authoritative natural and manmade aerospace prototype data sets. (PR: Executive Agent - TBD)

(a) Select specific transatmospheric and space environmental regimes and conditions for prototyping in FY 1996.

(b) Specify data accuracy, resolution levels, fidelity, degrees of precision, and formats required to support M&S functional areas by FY 1997.

(c) Develop, by FY 1997, data dictionaries describing location, feature content, lineage, current status, and attribution information for all aerospace data and data sets, including their relationship to each M&S resolution level and the particular portions of aerospace and astrodynamic environmental representation to which they apply.

(d) Define the data structure, coding and attribution scheme, symbology, and metadata requirements by FY 1997.

(e) Create an analytically useful depiction of the space environment by FY 1997.

(f) Demonstrate rapid, accurate, computer-assisted electronic, infrared, and radar data generation, modeling and display capabilities at all specified M&S resolution levels using controlled (all-source) imagery and intelligence information by FY 1997.

(3) Once developed, make all space representations available to the M&S community through the resource repository system. Initiate in FY 1996. Ongoing. (PR: Executive Agent - TBD)

(4) Nominate data exchange standards to ASD($C^3I$), as required, by second quarter FY 1996. (PR: Executive Agent - TBD)

(5) Demonstrate the capability to generate and receive data updates from multiple sources, and apply them to databases supporting engineering-grade synthetic environments (including full documentation of all appropriate configuration control and certification processes) by FY 1998. (PR: Executive Agent - TBD)

(6) Develop authoritative aerospace and astrodynamic process representations for selected M&S functional areas and synthetic environments. (PR: Executive Agent - TBD)

(a) Define standard and dynamic aerospace and astrodynamic process representations by FY 1998.

(b) Establish enhanced standard aerospace and astrodynamic process representations, consistent with all appropriate synthetic environments by FY 1999.

(c) Adapt appropriate dynamic environmental depiction methods, including internally consistent spatial frames of reference, to networks of models and complex interactive simulations by FY 1998.

(7) Develop a standard methodology for understanding and managing the space-related effects of interconnecting simulations within aerospace and astrodynamic synthetic environmental representations of differing resolution, scale, and scope by FY 1999. (PR: Executive Agent - TBD)

D. OBJECTIVE 3. Provide authoritative representations of systems.

NOTE: VV&A, resource repositories, and configuration control are addressed in Objective 5, section F.

1. Discussion. Systems include U.S., Allied, Coalition, and threat major platforms, weapons, sensors, units, life support systems, $C^4I$ systems, and logistics support systems. Authoritative representations of systems require models of the systems and their associated parameters which together provide V&V performance levels across a variety of conditions. In the aggregate this is a very large task and, for some systems (e.g., $C^4I$), a very difficult one.

2. Issues:

a. Development of community standards (e.g., resolution, fidelity) for specifying representations of systems for use throughout the life-cycle of systems.

b. Coordination of M&S development programs to cost-effectively provide the required population of system representations.

c. Development of acceptable algorithms for aggregating representations of single systems into groups of entities that cooperate as a unit.

d. Disaggregation of aggregated representations.

3. Actions:

a. Identify initial common object classes for representing systems beginning with platform representations, by second quarter FY 1996. (PR: EXCIMS)

b. As part of the architectural prototype efforts described under Objective 1, build examples, in FY 1995, of selected prototype classes of objects representing systems. (PR: AMG)

c. Assign Executive Agent development responsibility for common object classes (e.g., vehicles, aircraft, missiles, spacecraft), on the basis of current responsibility for real-world, physical entities by fourth quarter FY 1996. (Note: owning organizations maintain responsibility for each specific example within an object class.) (PR: USD(A&T))

d. Develop the system models and simulations required to satisfy the full range of DoD needs. Compile initial requirements by third quarter FY 1996; assign responsibilities by FY 1997. (PR: DoD Components)

e. Once developed, make all system representations available to the M&S community through the resource repository system. Initiate in FY 1996. Ongoing. (PR: DoD Components)

f. Develop methodologies, techniques, and algorithms by FY 1997 to facilitate implementation of aggregated representations of entities and disaggregation of higher-level representations into entities. (PR: To be determined (TBD))

E. OBJECTIVE 4. Provide authoritative representations of human behavior.

NOTE: VV&A, resource repositories, and configuration control are addressed in Objective 5, section F.

1. Discussion. Representations of humans and their behavior include human capabilities and limitations; individual and group performance; effects of organizational configuration and environment on performance; command, control and communications; and doctrine and tactics. Missions include combat operations, OOTW (e.g., peace-keeping, humanitarian relief, drug interdiction), and production and logistics with specific attention to joint operations.

2. Sub-objective 4-1. Develop authoritative representations of individual human behavior.[16]

a. Issues:

[16] Individual behavior includes both physiological and cognitive processes under varying situations and environmental conditions (e.g., morale, fatigue, stress, fear, and unpredictable behavior).

(1) Extension of existing models of combat operations to include individual combatants.

(2) Development of generic models of individual human capabilities, limitations, and performance (physiological and psychological).

(3) Development of the capability to rapidly construct models of individual human behavior for specific applications on demand.

b. Actions:

(1) Establish baseline behavioral model architectures and representational approaches by fourth quarter FY 1996. (PR: TBD)

(2) Establish a common behavioral model architecture by forth quarter FY 1997. (PR: TBD)

(3) Issue guidelines for the development of accredited behavioral representations of individual combatants by second quarter FY 1997. (PR: TBD)

(4) Develop operational definitions of behavioral variables[17] and categories[18] relevant to individual humans, and establish requirements and priorities for modeling these aspects of individual human behavior. Initiate in FY 1996. Complete by fourth quarter FY 1997. (PR: TBD)

(5) Develop initial prototypes of selected generic components, specified in terms of the above behavioral variables and categories, for models of individual human behavior in FY 1997. (PR: TBD)

(6) Once developed, make all representations of individual human behavior available to the M&S community through the resource repository system. Initiate in FY 1996. Ongoing. (PR: TBD)

(7) Develop standardized interfaces to facilitate the reuse of generic model components in different models of individual human behavior by FY 1997. (PR: TBD)

(8) Develop guidelines and a methodology for assessing requirements for modeling individual humans in M&S applications. Provide interim guidelines in FY 1996, final guidelines in FY 1996. (PR: TBD)

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[17] Behavioral variables include level of fidelity, resolution, and performance measures

[18] Behavioral categories include sensory, perceptual, physical, cognitive, social, and emotional behaviors.

(9) Develop tools and techniques to significantly improve existing capabilities to acquire knowledge about individual human performance by FY 1998. (PR: TBD)

(10) Develop models of individual human behavior using generic model components. Integrate models of human behavior into combat models and other applications. Initiate in FY 1997; ongoing. (PR: TBD)

3. Sub-objective 4-2. Develop authoritative representations of the behavior of groups and organizations.[19]

a. Issues:

(1) Extension of existing models of combat operations to cover friendly, threat, and neutral forces over all levels and functional areas.

(2) Development of generic representations of the behavior of groups and organizations or modeling a wide variety of potential adversaries and non-combatants (e.g., insurgents, terrorists, drug cartels). This also includes social, political, or economic behaviors that may be required to adequately portray OOTW.

(3) Development of the capability to rapidly construct models of group and organizational behavior for specific applications on demand.

b. Actions:

(1) Issue guidelines for the development of accredited behavioral representations of friendly, neutral, and hostile force organizations in FY 1996. (PR: TBD)

(2) Establish requirements and priorities for modeling OOTW in FY 1996. (PR: TBD)

(3) Develop representations of C3I structures and processes for military and non-military organizations. Initiate in FY 1995; complete in FY 2000. (PR: TBD)

(4) Develop operational definitions of behavioral variables and categories relevant to groups and organizations, and establish requirements and priorities for modeling these aspects of group and organizational behavior. Initiate in FY 1996. Complete by fourth quarter FY 1997. (PR: TBD)

(5) Develop initial prototypes of selected generic components, specified in terms of the behavioral variables and

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[19] Group and organizational behavior addresses group dynamics, leadership, team decision processes, doctrine, and tactics.

categories developed in Action E.3.b.(4) above, for models of group and organizational behavior in FY 1996. (PR: TBD)

(6) Once developed, make all representations of group and organizational behavior available to the M&S community through the resource repository system. Initiate in FY 1996; ongoing. (PR: TBD)

(7) Develop standardized interfaces to facilitate the reuse of generic model components in different models of group and organizational behavior by FY 1997. (PR: TBD)

(8) Develop guidelines and a methodology for assessing requirements for modeling groups and organizations in M&S applications. Develop interim guidelines in FY 1996, final guidelines in FY 1997. (PR: TBD)

(9) Develop tools and techniques to significantly improve existing capabilities to acquire knowledge about group and organizational performance by FY 1998. (PR: TBD)

(10) Develop models of group and organizational behavior using generic model components. Integrate models of group and organizational behavior into combat models and other applications. Initiate in FY 1997; ongoing. (PR: TBD)

F. OBJECTIVE 5. Provide a M&S infrastructure to meet developer and end-user needs.

1. Discussion. The M&S infrastructure consists of Component M&S systems and applications; VV&A; policy, procedures and support; resource repositories; communications; and a management organization to coordinate use of M&S resources.

2. Sub-objective 5-1. Field M&S systems in adequate numbers to meet end-user needs

a. Issues:

(1) Identification of M&S requirements.

(2) Total M&S system costs to support DoD Components.

(3) Acquisition and fielding of the appropriate numbers and types of M&S by Components to satisfy overall DoD capability needs.

(4) Increasing the utility of existing and future models and simulations by making them DIS-compliant.

b. Actions:

(1) Identify M&S cost drivers and develop cost-effective fielding options by FY 1997. (PR: DoD Components)

(2) Establish Component M&S requirements, with due regard for the needs of the entire DoD. Ongoing. (PR: DoD Components)

(3) Report Component M&S requirements in terms of capability and accessibility, in each of the three functional areas (training, analysis, acquisition), to DMSO within 6 months of the publication of this DoD M&S Master Plan, and update this report as changes occur. (PR: DoD Components)

(4) Plan, program, and budget for the fielding and interconnection of models and simulations. Ongoing. (PR: DoD Components)

(5) Phase out obsolescent M&S systems and research programs. Ongoing. (PR: DoD Components)

3. Sub-objective 5-2. Develop methodologies, standards, and procedures for the VV&A of models and simulations and the VV&C of data.

a. Discussion. V&V of models, simulations, and data are essential to gain the confidence of user organizations that M&S outcomes are representative of the real world, that they are reasonably correct, and that the models and simulations are acceptable for a specific purpose. V&V should be performed during the development of M&S and as part of M&S life-cycle management. Users must also properly accredit or certify each model, simulation, or data set as a prerequisite to its employment for each specific application.

b. Issues:

(1) Development of standards and procedures for V&V.

(2) Development of standards and procedures for accreditation.

(3) Development of standardized automated tools to support VV&A.

(4) Development of data certification standards and procedures, to include metrics to describe data quality.

(5) Maintenance of the history of VV&A and VV&C activities and their results.

c. Actions:

(1) Publish a DoD document establishing policy and assigning responsibilities for VV&A of M&S. Coordinate in FY 1995. Promulgate in FY 1996. (PR: USD(A&T)

(2) Develop prototype applications of VV&A to assess the trade-offs between the cost and time required for VV&A (using varying procedures) of M&S in various categories and the M&S improvement achieved under varying model circumstances (such as the maturity and complexity of the models). Perform pilot VV&A efforts in FY 1995 and FY 1996. (PR: MSWG)

(3) Establish general VV&A standards and procedures for M&S applications and specific standards and procedures as required for each M&S category in FY 1996. (PR: USD(A&T))

(4) Provide on-call technical support services to accreditation authorities beginning in FY 1996. (PR: DMSO)

(5) Publish a DoD document setting policy and assigning responsibilities for VV&C of data; coordinate in FY 1996; promulgate in FY 1997. (PR: USD(A&T))

(6) Establish VV&C standards and procedures for M&S applications in FY 1996. (PR: USD(A&T))

(7) Develop metrics for measuring data quality by fourth quarter FY 1996. (PR: DMSO)

(8) Once VV&A or VV&C has been performed, make histories of activities and results available to the M&S community through the resource repository system. Initiate in FY 1996. Ongoing. (PR: DoD Components)

4. Sub-objective 5-3. Provide a repository system to facilitate developer and end-user access to M&S resources.

a. Discussion. The Department of Defense must establish a distributed MSRR[20] system to efficiently and effectively provide the community with timely, verified, and validated data, metadata, algorithms, models, simulations, and tools. The MSRRs should also provide background information (e.g., model assumptions, source of data, classification of data, range of validity of algorithms, VV&A and/or VV&C history). This will promote reuse and sharing of M&S resources and will improve credibility of M&S results. The repository will provide tools for configuration management and for accessing, browsing, and retrieving M&S resources.

b. Issues:

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[20] The Modeling and Simulation Resource Repository system is a functionally oriented, internetted, distributed system for sharing and maintaining models, simulations, data, metatdata, algorithms, and tools.

(1) Access and reuse of M&S resources across the Department of Defense.

(2) Identification of authoritative data sources for M&S resources.

(3) Configuration control of M&S reusable resources (e.g., data, algorithms, models, simulations, tools).

(4) Identification of data security requirements.

c. Actions:

(1) Develop a distributed MSRR system providing: (a) directories/catalogs; (b) data standardization resources (e.g., process and data models, data dictionary); (c) reusable data, algorithms, models and simulations; and (d) tools for browsing and accessing, linking across resources, configuration management, etc. Develop an unclassified interim MSRR (iMSRR) repository system in FY 1995; classified iMSRR in FY 1996. Complete Baseline I System FY 1997; provide Baseline II System FY 1998. Initiate DoD-wide distribution in first quarter FY 1999. (Repository requirements for authoritative representations of the environment, systems, humans and their behavior are being provided under Objectives 2, 3, and 4, sections B., C., and E.) (PR: DMSO)

(2) Develop a M&S taxonomy for use in identifying authoritative data sources. Establish responsibilities and provide a directory to authoritative data sources as part of the MSRR. Initial directory and assignment of responsibilities will be completed in FY 1995. (PR: DMSO)

(3) Define specific M&S data security requirements for access across repositories in FY 1996. (PR: DMSO)

(4) Develop configuration control procedures and tools to access, modify, and update the resources (e.g., process models, data models, directories, data, algorithms, models and simulations, authoritative data sources) in the MSRR. Prototype by FY 1997; provide limited operational capability by second quarter FY 1998. (PR: DMSO)

5. Sub-objective 5-4. Provide a communications infrastructure adequate to meet M&S user needs.

a. Issues:

(1) Transition of the current DSI to an operational service with improved reliability and increased bandwidth.

(2) Utilization of Defense Information infrastructure and commercial communication services.

(3) Utilization of radio frequency (RF) communications (e.g., satellite communications, Single Channel Ground Airborne Radio System, International Maritime Satellite) to support M&S and its interface with $C^4I$ systems.

(4) Accommodation of large numbers of operational users involved in large numbers of simultaneous simulation exercises.

(5) Utilization of improved encryption devices under development by National Security Agency to provide higher capacity than those currently used on the DSI.

(6) Implementation of MLS.

b. Actions:

(1) Provide DSI communications services to ensure that M&S user needs are met. Ongoing. (PR: ASD($C^3I$))

(2) Broaden the range of alternative communications means to support the M&S community, including commercial services and RF links. Ongoing. (PR: ASD($C^3I$))

(3) Obtain appropriate encryption devices to support classified M&S. Ongoing. (PR: DoD Components)

(4) Advocate M&S requirements in the development of emerging communications standards (e.g., multicasting and resource reservation). Ongoing. (PR: DMSO)

(5) Provide MLS to link simulation participants in FY 1999. (PR: ASD($C^3I$))

6. Sub-objective 5-5. Provide operational support for the effective, efficient, and responsive application of world-wide simulation capabilities to meet user (e.g., operating forces, acquisition managers, staff analyst) needs.

a. Discussion: There is a need for a central organization to advise users of M&S suitability, to coordinate M&S asset availability, to provide useful information on M&S support requirements and practices, and to coordinate user requests for M&S assets in support of mission needs.

b. Issues:

(1) Coordinated utilization of DoD's simulation assets.

(2) Coordination of support for the planning, set-up, and execution of M&S supported activities in an operationally responsive, cost-effective manner.

(3) Establishment of a central activity for obtaining M&S support.

(4) Identification of requirements to conduct distributed simulation exercises.

(5) Coordination of outside demands for M&S support to minimize the impact on owning organizations.

c. Actions:

(1) Establish a M&S Operational Support Activity (MSOSA) as an operations support activity to coordinate utilization of M&S assets among DoD Components. The MSOSA will assist M&S users in the planning, setup, execution, and monitoring of M&S events. Initiate study and coordination in FY 1995; designate responsible organizations by FY 1996; make operational by FY 1997. (PR: USD(A&T))

(2) Identify focal points for each Component to work with the MSOSA to plan and coordinate use of distributed simulation assets. Identify in FY 1996. (PR: DoD Components)

(3) Identify notional requirements for distributed simulation exercises by FY 1997. (PR: DoD Components)

G. OBJECTIVE 6. Share the benefits of M&S.

1. Sub-objective 6-1. Quantify the impacts of M&S.

a. Discussion. Achieving the DoD M&S vision requires more than just providing technical capabilities. Users must be convinced that M&S support of their operations is both operationally effective and cost effective. Thus, it will be necessary to analyze and demonstrate the use of M&S to support specific functional needs. Quantitative measures of the benefits that clearly demonstrate the impact of M&S must be developed. The results will be disseminated to the Department of Defense, Congress, other government agencies, and industry.

b. Issue. Development of quantitative measures (e.g., readiness impact, cost savings and effectiveness) of the benefits of M&S to support investment decisions.

c. Actions:

(1) Develop metrics to allow assessment of the utility of M&S in FY 1995. (PR: DoD Components)

(2) Collect and analyze data from ongoing efforts, planned experiments, and demonstrations to assess the impacts of M&S. Initiate in FY 1995, and maintain as a continuing activity. (PR: DoD Components)

(3) Establish the DoD-wide impact of M&S based on Component inputs from Action G.1.c.(2) above. (PR: DMSO)

2. Sub-objective 6-2. Education of potential M&S users.

a. Discussion. Managers need to be educated about the advantages and disadvantages of different M&S applications and the functions that they support. New users of models and simulations need instruction on how to set up their own models and simulations.

b. Issue. Expansion of user awareness and sharing of information across the M&S community.

c. Actions:

(1) Conduct M&S demonstrations addressing user needs. Ongoing. (PR: DoD Components)

(2) Expand the M&S Information System to include a broad knowledge base supporting the M&S community's development efforts in FY 1996. (PR: DMSO)

(3) Develop and maintain information papers and short courses on M&S beginning in FY 1996. (PR: DoD Components)

(4) Conduct and participate in seminars, symposia, and workshops on M&S. Ongoing. (PR: DoD Components)

3. Sub-objective 6-3. Support bi-directional technology transfer with other government agencies, industry, and allied nations.

a. Discussion. Technology transfer with other government agencies, private industry, and allied nations will promote dual-use and lead to improved capabilities by both DoD and non-DoD organizations. Technology transfer will be promoted only when appropriate and consistent with protection of U.S. Government proprietary intellectual property and security policy.

b. Issues:

(1) Promotion of faster and more extensive technology transfer with other government agencies, industry, and allied nations.

(2) Establishment of international standards for M&S.

(3) Establishment of security policy regarding the release of models and data bases of U.S. and threat capabilities.

c. Actions:

(1) Provide cost-effective, on-line access to technical information provided by the Components by fourth quarter FY 1996. (PR: DMSO)

(2) Conduct regular and frequent technology exchange meetings beginning in FY 1996. (PR: DoD Components)

(3) Invite other government agencies, industry, universities, and allied nations to observe or participate in M&S experiments and demonstrations, seminars, workshops, and international working groups (e.g., North Atlantic Treaty Organization Research Study Groups). Begin in FY 1995, and maintain as a continuing activity. (PR: DoD Components)

(4) Nominate evolving DoD simulation standards (e.g., DIS) for adoption by the International Standards Organization by FY 1996. (PR: DDR&E)

(5) Provide representation to all standards development bodies potentially involving M&S (e.g., Object Management Group, Open Systems Foundation, National Institute for Standards and Technology) by third quarter FY 1995 to ensure that DoD needs are satisfied. (PR: TBD)

(6) Develop security policy guidance concerning the release of models and data bases of U.S. and threat capabilities by fourth quarter FY 1996. (PR: TBD)

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# APPENDIX A

# ACRONYMS AND DEFINITIONS

## A. ACRONYMS

| | |
|---|---|
| AFPEO/CB | Air Force Program Executive Office/Combat Systems Support |
| AF/XOM | Headquarters USAF, Director for Modeling, Simulation and Analysis |
| ALSP | Aggregate Level Simulation Protocol |
| AMG | Architecture Management Group |
| ARPA | Advanced Research Projects Agency |
| ASD | Assistant Secretary of Defense |
| ASD(C3I) | ASD for Command, Control, Communications and Intelligence |
| ASD(RA) | ASD for Reserve Affairs |
| $C^2W$ | Command and Control Warfare |
| $C^3I$ | Command, Control, Communications, and Intelligence |
| $C^4I$ | Command, Control, Communications, Computers, and Intelligence |
| CMMS | Conceptual Model of the Mission Space |
| DAB | Defense Acquisition Board |
| DASP | Data Administration Strategic Plan |
| DDR&E | Director of Defense Research and Engineering |
| DDRS | Department of Defense Repository System |
| DIA | Defense Intelligence Agency |
| DIS | Distributed Interactive Simulation |
| DISA | Defense Information Systems Agency |
| DJS | Dirctor, Joint Staff |
| DMA | Defense Mapping Agency |
| DMSO | Defense Modeling and Simulation Office |
| DoD | Department of Defense |
| DoNMSMO | Department of the Navy M&S Management Office |
| DOT&E | Director, Operational Test and Evaluation |
| DREN | Defense Research and Engineering Network |
| DRTWG | Data and Repositories Technology Working Group |
| DSB | Defense Science Board |
| DSI | Defense Simulation Internet |
| DUSA(OR) | Deputy Under Secretary of the Army for Operations Research |
| DUSD | Deputy Under Secretary of Defense |
| DUSD(R) | DUSD for Readiness |
| EXCIMS | Executive Council for Modeling and Simulation |
| FDAd | Functional Data Administrator |
| FWG | Functional Working Group |
| FY | Fiscal Year |
| HLA | High-Level Architecture |

| | |
|---|---|
| IEEE | Institute of Electrical and Electronic Engineers |
| iMSRR | interim M&S Resource Repository |
| J-8 | The Joint Staff, Director for Force Structure, Resources & Assessment |
| JROC | Joint Requirements Oversight Council |
| J-7 | The Joint Staff, Director for Operational Plans and Interoperability |
| JSIMS | Joint Simulation System |
| JTASC | Joint Training, Analysis, and Simulation Center |
| JWARS | Joint Warfare System |
| JWFC | Joint Warfighting Center |
| M&S | Modeling and Simulation |
| MCMSMO | Marine Corps M&S Management Office |
| MLS | Multi-Level Security |
| ModSAF | Modular Semi-Automated Forces |
| MSEA | Modeling and Simulation Executive Agent |
| MSIP | Modeling and Simulation Investment Plan |
| MSOSA | Modeling and Simulation Operational Support Activity |
| MSRR | Modeling and Simulation Resource Repository |
| MSWG | Modeling and Simulation Working Group |
| N096 | Oceanographer of the Navy |
| N6 | Director, Space & Electronic Warfare |
| N7 | Director of Naval Training |
| N8 | Deputy Chief of Naval Operations for Resources, Warfare Requirements & Assessments |
| OD(PA&E) | Office of the Director, Program Analysis & Evaluation |
| OD(TSE&E) | Office of the Director, Test, System Engineering and Evaluation |
| OOTW | Operations Other Than War |
| OSD | Office of the Secretary of Defense |
| PDU | Protocol Data Unit |
| PPBS | Planning, Programming, and Budgeting System |
| PR | Primary Responsibility |
| PSA | Principal Staff Assistant |
| RF | Radio Frequency |
| RTI | Runtime Infrastructure |
| SIMNET | Simulation Network |
| STOW | Synthetic Theater of War |
| STOW-E | Synthetic Theater of War-Europe |
| TBD | To be determined |
| UCC | Unified Combatant Command |
| UJTL | Universal Joint Task List |
| USACOM | U. S. Atlantic Command |
| USCENTCOM | U. S. Central Command |
| USD | Under Secretary of Defense |
| USD(A&T) | USD for Acquisition & Technology |
| USD(C) | USD for Comptroller |
| USD(P) | USD for Policy |

| | |
|---|---|
| USD(P&R) | USD for Personnel and Readiness |
| USEUCOM | U.S. European Command |
| USPACOM | U. S. Pacific Command |
| USSOUTHCOM | U. S. Southern Command |
| USSPACECOM | U. S. Space Command |
| USSOCOM | U. S. Special Operations Command |
| USSTRATCOM | U. S. Strategic Command |
| USTRANSCOM | U. S. Transportation Command |
| V&V | Verification and Validation |
| VCJCS | Vice Chairman of the Joint Chiefs of Staff |
| VVA or VV&A | Verification, Validation, and Accreditation |
| VV&C | Verification, Validation, and Certification |

B. DEFINITIONS

1. Accreditation. The official certification that a model or simulation is acceptable for use for a specific purpose.

2. Aggregate Level Simulation Protocol (ALSP). A family of simulation interface protocols and supporting infrastructure software that permit the integration of distinct simulations and war games. Combined, the interface protocols and software enable large-scale, distributed simulations and war games of different domains to interact at the combat object and event level. The most widely known example of an ALSP confederation is the Joint/Service Training Confederation (Corps Battle Simulation; Air Warfare Simulation; Joint Electronic Combat/Electronic Warfare Simulation; Research, Evaluation, and System Analysis; Marine Air-Ground Task Force - Tactical Wargaming System; Tactical Simulation; Combat Service Support Training Simulation System) which has provided the backbone to many large, distributed, simulation-supported exercises. Other examples of ALSP confederations include confederations of analytical models that have been formed to support U.S. Air Force, U.S. Army, and U.S. Transportation Command studies.

3. Aggregation. The ability to group entities while preserving the collective effects of entity behavior and interaction while grouped. (See also definition of disaggregation.)

4. Architecture. The structure of components in a program/system, their interrelationships, and principles and guidelines governing their design and evolution over time.

5. Authoritative Representation. Models, algorithms, and data that have been developed or approved by a source which has accurate technical knowledge of the entity or phenomenon to be modeled and its effects.

6. Command Forces (CFOR). An ARPA ADS Program with the goal to represent $C^4I$ in DIS.

7. Command and Control Warfare (C2W). The integrated use of operations security, military deception, psychological operations, electronic warfare, and physical destruction, mutually supported by intelligence, to deny information to, influence, degrade, or destroy adversary C2 capabilities, while protecting friendly C2 capabilities against such actions.

8. Commander in Chief (CINC). A position established under the authority of 10 U.S.C. (reference (j)) to designate an officer assigned by the President as the Commander of a Unified Combatant Command and who is directly responsible to the President of the United States and Secretary of Defense for the performance of missions assigned to that command by the President or by the Secretary of Defense with the approval of the President. Subject to the direction of the President, the Commander of a Unified Combatant Command performs his duties under the authority, direction, and control of the Secretary of Defense and is directly responsible to the Secretary of Defense for the preparedness of the command to carry out missions assigned to the command.

9. Common-use M&S. M&S applications, services, or materials provided by a DoD Component to two or more DoD Components.

10. Complex Data. Data that cannot be characterized as a single concept, atomic data element as defined in DoD 8320.1-M-1 reference (k). Complex data includes most scientific and technical data. It has been recently categorized by the Complex Data Task Force into:

a. Highly derived data (e.g., probability hit/kill);

b. Objects utilizing the concepts of multiple inheritance (e.g., student-assistant is subclass of student class and employee class), multiple root hierarchies (e.g., a tank is a vehicle and a tank is a weapon where "vehicle" and "weapon" are each roots), and polymorphic attributes (e.g., "capacity" for different types of aircraft may mean number of people, pounds of cargo, or gallons of fuel);

c. Compositions such as command hierarchies, road networks, images (binary large objects), compound documents; and,

d. Artifacts of legacy systems and physical constraints (e.g., aircraft category and mission in one data element, intelligence facility code where the first few bytes define how the rest of the field is used).

11. Computer Generated Forces (CGF). A generic term used to refer to computer representations of forces in simulations that attempts to model human behavior sufficiently so that the forces will take some actions automatically (without requiring man-in-

the-loop interaction). Also referred to as Semi-automated Forces (SAFOR). DoD programs addressing various levels of computer automation of forces include Command Forces, Intelligent Forces, Modular Semi-Automated Forces, Integrated Tactical Environment Management System, and Close Combat Tactical Trainer Semi-Automated Forces.

12. Constructive Model or Simulation. See Live, Virtual and Constructive Simulation.

13. Data Certification. The determination that data have been verified and validated. Data user certification is the determination by the application sponsor or designated agent that data have been verified and validated as appropriate for the specific M&S usage. Data producer certification is the determination by the data producer that data have been verified and validated against documented standards or criteria.

14. Data Dictionary. A table or set of records whose values define the allowable content and meaning of attributes.

15. Data Quality. The correctness, timeliness, accuracy, completeness, relevance, and accessibility that make data appropriate for use. Quality statements are required for source, accuracy (positional and attribute), up-to-dateness/currency, logical consistency, completeness (feature and attribute), clipping indicator, security classification, and releasability.

16. Data Verification, Validation, & Certification (VV&C). The process of verifying the internal consistency and correctness of data, validating that it represents real world entities appropriate for its intended purpose or an expected range of purposes, and certifying it as having a specified level of quality or as being appropriate for a specified use, type of use, or range of uses. The process has two perspectives: producer and user process.

17. Data Validation. The documented assessment of data by subject area experts and its comparison to known values. Data user validation is that documented assessment of data as appropriate for use in an intended model. Data producer validation is that documented assessment within stated criteria and assumptions.

18. Data Verification. Data producer verification is the use of techniques and procedures to ensure that data meets constraints defined by data standards and business rules derived from process and data modeling. Data user verification is the use of techniques and procedures to ensure that data meets user specified constraints defined by data standards and business rules derived from process and data modeling, and that data are transformed and formatted properly.

19. Defense Simulation Internet (DSI). A wide-band telecommunications network operated over commercial lines with connectivity to both military and civilian satellites, allowing users to be linked on a world-wide wide-area network (WAN).

20. Disaggregation. The ability to represent the behavior of an aggregated unit in terms of its component entities. If the aggregate representation did not maintain state representations of the individual entities, then the decomposition into the entities can only be notional.

21. Distributed Interactive Simulation (DIS).

a. Program to electronically link organizations operating in four domains: advanced concepts and requirements; military operations; research, development, and acquisition; and training.

b. A synthetic environment within which humans may interact through simulation(s) at multiple sites networked using compliant architecture, modeling, protocols, standards, and databases.

22. DoD M&S Executive Agent. A DoD Component to whom the USD(A&T) has assigned responsibility and delegated authority for the development and maintenance of a specific area of M&S application, including relevant standards and databases, used by or common to many models and simulations.

23. Environmental Representation. An authoritative representation of all or a part of the natural environment, including permanent or semi-permanent man-made features.

24. Executive Agent. See DoD M&S Executive Agent.

25. Executive Council for Modeling and Simulations (EXCIMS). An organization established by the USD(A&T) responsible for providing advice and assistance on DoD M&S issues. Membership is determined by the USD(A&T) and is at the Senior Executive Service, flag, and general officer level.

26. Fidelity. The accuracy of the representation when compared to the real-world.

27. Functional Area. A functional area encompasses the scope (the boundaries) of a set of related functions and data for which an OSD Principal Staff Assistant or the Chairman of the Joint Chiefs of Staff has DoD-wide responsibility, authority, and accountability. A functional area (e.g., personnel) is composed of one or more functional activities (e;g;, recruiting), each of which consists of one or more functional processes (e.g., interviews). Also known as a business area.

28. Functional Data Administrator (FDAd). An FDAd is a person or group that ensure the utility or data used within the Functional Area by defining data policies and standards, planning for the efficient use of data, coordinating data structures among organizational components, performing logical database design, and defining data security procedures.

29. General-use M&S Applications. Specific representations of the physical environment or environmental effects used by, or common to, many models and simulations (e.g., terrain, atmospheric or hydrographic effects).

30. Infrastructure. See M&S Infrastructure.

31. Intelligence Community Coordinating Group (ICCOG). The ICCOG serves as the intelligence community's forum for M&S exchange, fostering improved communication among community and other government agencies and industry. The ICCOG promotes sharing of programs, methodologies, tools, techniques, data and other information.

32. Intelligent Forces (IFOR). A specific program funded by ARPA to build a maximum of intelligent behavior into the computer representations of forces.

33. Interoperability. See M&S Interoperability.

34. Joint M&S. Representations of joint and Service forces, capabilities, equipment, materiel, and services used by the joint community or by two, or more, Military Services.

35. Live Simulation. See Live, Virtual, and Constructive Simulation.

36. Live, Virtual, and Constructive Simulation. A broadly used taxonomy for classifying simulation types. The categorization of simulation into live, virtual, and constructive is problematic, because there is no clear division between these categories. The degree of human participation in the simulation is infinitely variable, as is the degree of equipment realism. This categorization of simulations also suffers by excluding a category for simulated people working real equipment (e.g., smart vehicles).

a. Live Simulation. A simulation involving real people operating real systems.

b. Virtual Simulation. A simulation involving real people operating simulated systems. Virtual simulations inject human-in-the-loop (HITL) in a central role by exercising motor control skills (e.g., flying an airplane), decision skills (e.g., commit

ting fire control resources to action), or communication skills (e.g., as members of a C4I team).

c. Constructive Model or Simulation. Models and simulations that involve simulated people operating simulated systems. Real people stimulate (make inputs) to such simulations, but are not involved in determining the outcomes.

37. Metadata. Data that describes data. Examples: definition, classification, accuracy, data type, precision, currency, source, effective dates, etc.

38. Mission Space. The environment of entities, actions, and interactions comprising the set of interrelated processes used by individuals and organizations to accomplish assigned tasks.

39. Model. A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process.

40. M&S Infrastructure. An underlying base or foundation; the basic facilities, equipment, installations and services needed for the functioning of a system. An M&S infrastructure would consist of M&S systems and applications, communications, networks, architectures, standards and protocols, information resource repositories, etc.

41. M&S Interoperability. The ability of a model or simulation to provide services to, and accept services from, other models and simulations, and to use the services so exchanged to enable them to operate effectively together.

42. M&S Working Group (MSWG). The MSWG supports the activities of the EXCIMS and responds to guidance and direction from the USD(A&T). The Director, DMSO, chairs the MSWG. The membership of the MSWG will normally be O-6 military officers or GM-15 grade civilians. The MSWG promotes coordination and cooperation of DoD M&S at the working level. Members will represent their organization, serve as the DMSO point of contact for M&S issues, and prepare their principals for EXCIMS meetings. MSWG membership will mirror the organizational makeup of the EXCIMS; however, other organizations may be added by majority vote of the group, as required.

43. Modular Semi-Automated Forces (ModSAF). A class of CGF utilizing a modular software structure in which model components have well-defined and documented interfaces allowing run-time reconfiguration of model behavior to develop generalized, and more sophisticated, representations of reactive behaviors and missions. ModSAF provides an open architecture that is expected to be the starting point for future extensions of SAFOR capabilities.

44. Multi-State Objects. Mission space entities that express a changing state (in attribution and visual display) as the simulation progresses (e.g., damage to structures, changes in vegetation, damage system representations such as vehicles, tanks, etc.).

45. Protocol. A set of rules and formats (semantic and syntactic) that determine the communication behavior of simulation applications.

46. Protocol Data Unit (PDU). DIS terminology for a unit of data that is passed on a network between simulation applications.

47. Resolution. The degree of detail and precision used in the representation of real-world aspects in a model or simulation; granularity.

48. Scalability. The ability of a distributed simulation to maintain time and spatial consistency as the number of entities and accompanying interactions increase.

49. Semi-Automated Forces (SAFOR). See Computer Generated Forces.

50. Simulation. A method for implementing a model over time.

51. Standard. A rule, principle, or measurement established by authority, custom, or general consent as a representation or example.

52. Synthetic Battlefield. One type of synthetic environment.

53. Synthetic Environments (SE). Internetted simulations that represent activities at a high level of realism from simulations of theaters of war to factories and manufacturing processes. These environments may be created within a single computer or over a distributed network connected by local and wide area networks and augmented by realistic special effects and accurate behavioral models. They allow visualization of and immersion into the environment being simulated.

54. Unified Combatant Command (UCC). One of the unified combatant commands established by the President of the United States according to 10 U.S.C. (reference (j)). Also referred to as Combatant Commands. (UCCs include: U. S. Atlantic Command; U.S. Central Command; U. S. European Command; U. S. Pacific Command; U. S. Southern Command; U. S. Space Command; U. S. Special Operations Command; U. S. Strategic Command; and, U. S. Transportation Command. (See definition 8 and Acronyms.)

55. Validation. The process of determining the extent to which a model or simulation is an accurate representation of the real world from the perspective of the intended use(s) of the model or simulation.

56. Verification. The process of determining that a model or simulation implementation accurately represents the developer's conceptual description and specification. Verification also evaluates the extent to which the model or simulation has been developed using sound and established software engineering techniques.

57. Virtual Prototype. A model or simulation of a system placed in a synthetic environment, and used to investigate and evaluate requirements, concepts, system design, testing, production, and sustainment of the system throughout its life cycle.

**58. Virtual Simulation. See Live, Virtual, and Constructive Simulation**

# APPENDIX B
# DOD INVESTMENT PLAN

To be provided.

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# APPENDIX C
# ACQUISITION FUNCTIONAL AREA PLAN

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# APPENDIX D

## ANALYSIS FUNCTIONAL AREA PLAN

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# APPENDIX E

## TRAINING FUNCTIONAL AREA PLAN

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# APPENDICES F TO X

## RESERVED FOR FUTURE USE

Additional Appendices will be added as needed.

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# APPENDIX Y

## PLAN MAINTENANCE

A. DoD 5000.59-P is to be a “living” document that reflects current requirements and technologies. Changes will be made according to guidance in DoD 5025.1-M, "DoD Directives System Procedures," (reference (l)). The DMSO maintains and administers this plan as directed by the USD(A&T) and is the focal point for actions regarding this Plan. The following tabble lists effective pages for this Plan. This list confirms the currency and completeness of the document.

| Page | Change |
|---|---|
| Front Cover | 0 |
| Tab, Introduction | 0 |
| i thru vi | 0 |
| Tab, Chapter 1 | 0 |
| 1-1 thru 1-6 | 0 |
| Tab, Chapter 2 | 0 |
| 2-1 thru 2-8 | 0 |
| Tab, Chapter 3 | 0 |
| 3-1 thru 3-8 | 0 |
| Tab, Chapter 4 | 0 |
| 4-1 thru 4-30 | 0 |
| Tab, Appendices | 0 |
| A-1 thru A-10 | 0 |
| B-1 thru B-2 | 0 |
| C-1 thru C-2 | 0 |
| D-1 thru D-2 | 0 |
| E-1 thru E-2 | 0 |
| F-1 thru X-1 | 0 |
| Y-1 thru Y-2 | 0 |
| Z-1 thru Z-2 | 0 |
| Rear Cover | 0 |

Table Y-1. Page Number and Currency Guide.

B. Use the following table to record changes to this plan:

| Change No. | Date of Change | Date Entered | Entered by |
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Table Y-2. Record of Plan Maintenance.

# APPENDIX Z

## REFERENCES


(a) DoD Directive 5000.59, "DoD Modeling and Simulation (M&S) Management," January 4, 1994
(b) Senate Authorization Committee Report, FY91, DoD Appropriations Bill, SR 101-521, pp. 154-155, October 11, 1990
(c) Defense Science Board, Office of the Under Secretary of Defense for Acquisition, "Report of the Defense Science Board Task Force on Advanced Distributed Simulation," August 1994
(d) Defense Science Board, Office of the Under Secretary of Defense for Acquisition and Technology, "Report of the Defense Science Board Task Force on Readiness," June 1994
(e) Office of the Director, Defense Research and Engineering, "Final Report of the Acquisition Task Force on Modeling and Simulation," June 17, 1994
(f) Defense Science Board, Office of the Under Secretary of Defense for Research and Engineering, "Report of the Defense Science Board Task Force on Computer Applications to Training and Wargaming," May 1988
(g) Weatherly, Richard, et al, "Aggregate Level Simulation Protocol," The Proceedings of the 1991 Summer Computer Simulation Conference, Baltimore, MD, July 22-24, 1991, pp. 953-958
(h) Office of the Director, Defense Research and Engineering, "Modeling and Simulation (M&S) Data Administration Strategic Plan, Fiscal Years 1995-2002," April 1995
(i) Army Pamphlet 5-11, "VV&A of Army Models and Simulations," November 1993
(J) Title 10, United States Code
(k) DoD 8320.1-M-1, "Data Element Standardization Procedures," Mar 1994, authorized by DoD Directive 8320.1, September 26, 1991
(l) DoD 5025.1-M, "DoD Directives System Procedures," August 1994, authorized by DoD Directive 5025.1, June 24, 1994

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